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TELEVISION TROUBLE-SHOOTER

HOW TO ADJUST AND REPAIR YOUR SET

This Book TELLS AND ILLUSTRATES *How to.....*

- MAKE YOUR OWN ADJUSTMENTS
- UNDERSTAND ANTENNA PROBLEMS
- LOCATE TUBE TROUBLES
- MAKE MINOR REPAIRS

and EXPLAINS HOW TV PICTURES ARE PRODUCED

. . . INCLUDING A SECTION ON RADIO REPAIRS

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TELEVISION
TROUBLE-SHOOTER

A Manual for Adjustments and Minor Repairs

by

Herschel L. Stark
Government Licensed Television and Radio Engineer

Consult "TABLE OF CONTENTS"
for numerous, helpful topics

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INTRODUCTION

The author of this book has been working with radios, radio and television equipment, and in broadcasting stations for the past twenty years. The suggestions, hints, and instructions contained herein constitute the greatest possible collection of things you, the television and radio set owner, can do for yourself.

When your television or radio set developed some difficulty, you may have wished that there was something you could do. Isn't it due possibly to some reasonably simple thing, you may have thought, which, if you just knew where to look, you might perhaps fix yourself and save money?

Many times a few words of advice from an experienced technician would enable you to do just that. This book provides a ready source of a wealth of such advice. From beginning to end, it is written as though the author were sitting and talking with you, pointing out in words and with drawings how you, yourself, can track down many troubles by following a step-by-step, organized procedure.

A word of suggestion—when your television or radio set is in trouble and you wish to search out the possible cause, first glance through the book and in the Table of Contents for the chapter and sections dealing with your immediate problem. Having found them, read completely through these sections before beginning work. Following this plan will give you a clearer idea, and may save unnecessary work. Also, in the matter of television adjustments, performing one operation may depend on, or result in, the doing of some other thing. Thus reading completely through the sections dealing with the problem at hand will better equip you to intelligently approach the job.

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CHAPTER I

TELEVISION ADJUSTMENTS

(1) GENERAL INTRODUCTORY SUGGESTIONS

Basically, there are about nine different faults a television picture can develop, which in most instances you, yourself, can correct by means of comparatively simple adjustments. The controls for making these adjustments are found in various locations on different makes and models. Focus (clarity of the picture), for example, is controlled with a knob on the front panel of some TV sets, while on others it must be adjusted with a screw driver at the rear of the set.

At the rear of the set you should find several controls, which in most cases are slotted, to be turned with a screw driver, although on some sets they have their shafts extended about a half inch and knurled for gripping with the fingers. Or they may have small knobs, and in some few instances you might find some of eac' on the same set—one or more with screw driver slots, and others with knurled shafts or knobs.

Each control you will be using has its name stamped clearly nearby. There are many screw driver adjustments on a TV set which are not marked or identified,—never turn them. They are explained to the professional serviceman in literature published by the manufacturer, and are to be used in case a complete realignment of the set should ever be necessary.

Never turn any adjustment which is not marked, or one the use of which you do not understand. It is the purpose of this book to help you save money by making many simple adjustments and repairs without any special equipment or technical knowledge. It definitely is not its purpose to induce you to fool with unmarked controls. If, however, you follow the instructions contained herein, you will be able to make many adjustments and perhaps repairs for which you would otherwise have to spend considerable money on calling in servicemen.

It would be wise for you to read completely through these instructions before attempting any adjustments. The reason for this is that some adjustments are dependent on one another. Adjusting one control may make it desirable to slightly readjust some other control. This will become clear to you as you proceed through the instructions.

A particular thought, which if borne constantly in mind will save you considerable doubt and confusion, is the fact that among various makes and models of television receivers, some controls performing exactly the same function are designated by slightly different names. These different names will be stated when explaining the various adjustments to be made. One example is the control for adjusting the WIDTH of the picture; some manufacturers call it simply WIDTH, others state it as HORIZONTAL SIZE. One can see immediately that these two names mean precisely the same thing. Along this same line is the idea that whenever the crosswise dimension of a picture is being considered, the word HORIZONTAL is used. Similarly the word VERTICAL is used to express anything up and down in the picture. See figure 1. Common abbreviations for these words are HORIZ. and HOR. for HORIZONTAL, and VERT. and VER. for VERTICAL.

Extremely Important Note Do Not Fail to Heed

Above all, before attempting to turn any adjustments (with the exception of those on the front panel used in routine tuning), mark their position so that at any time you desire, you can return them to their former settings and start all over again. The reason this is so important is that in adjusting two or three controls at once, it is very easy to get confused and turn one too far, and then turn another control in trying to rectify the difficulty. If at that time you can simply turn them all back to their original settings and begin once more, you can save yourself much bother and time.

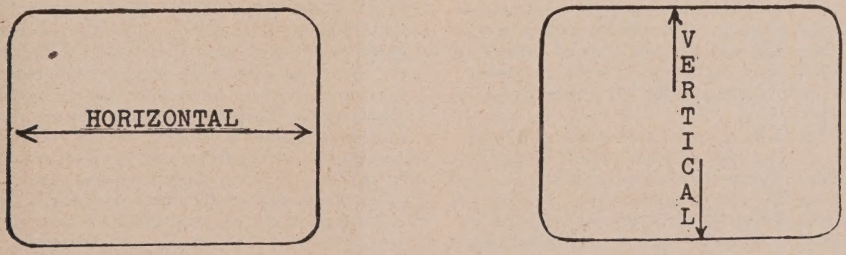


Figure 1.

Most screw driver adjustments cannot be turned more than one revolution. Marking these is simple—just use a lead pencil to make a mark on the control itself, and a mark on the chassis just opposite the first mark, as shown in figure 2. This will make it very easy for you to return it to its former setting any time you wish. A few

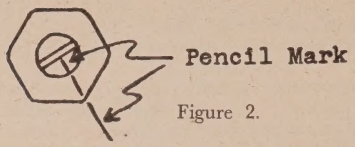


Figure 2.

controls, however, are in the form of a long-threaded screw (described and illustrated under WIDTH adjustments); for these controls, take a ruler and measure as shown in figure 3, and write down the measurement from the end of the screw to the solid piece into which it screws. Then, should you ever desire to return this control to its original setting, simply screw it out or in until this measurement is again reached.

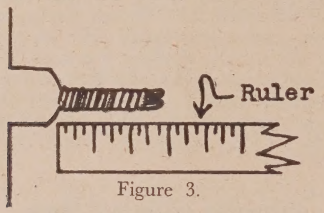


Figure 3.

If, while reading these instructions, you are unable to readily locate some of the controls needed to perform the indicated adjustments, either on the front panel or at the rear of the set, it is possible that you may have a model which has several control adjustments concealed behind some kind of removable panel on the front. Several manufacturers have made some sets in this way. It is impossible to list all the specific instances here, but a few typical examples are:

At least one make and model has a ventilating screen on each side of the picture screen. One of them can be removed to expose seven adjustments.

More than one manufacturer has provided a removable nameplate on the front panel behind which there are several controls.

There are models which have a more or less long slender panel just beneath the picture screen which when removed exposes a metal protective plate held in place by screws. Loosen the screws and slide the plate to one side for access to control adjustments.

This list is by no means complete. It should, however, give an idea of what to look for in any circumstance. It may be that on your set, all controls are readily accessible. However, if some of the controls needed to make the adjustments explained in the following sections cannot be found in plain sight, examine your set for the above mentioned hidden controls. Sometimes a removable panel will be hinged. In other cases it will be secured in place by some form of snaps, and will come off with a steady, forward pull. Nameplates may be held in place with screws. In no case should you risk breakage by exerting abnormal force.

The dealer where you purchased your set should be willing to tell you about any removable panels on your set if he understands that you wish to make only such adjustments as picture size, linearity, etc.

There is a possibility of one or more controls being located on the same part of the chassis with the tubes. If so, you may need a flashlight to see them.

Remember the caution of not turning any adjustments, the action of which you do not understand.

Removing the Rear Cover of the Cabinet

When for any reason you wish to remove the rear cover of the cabinet, give careful attention to the following.

The rear cover of many sets is so made that when it is not in place the set cannot be turned on. This is for your protection because of the extremely high voltage in a TV set. You can tell as soon as you remove all the screws from around the sides of the cover whether or not it is equipped with this safety feature—called an interlock. If the cover comes off, free of the electric cord, it is not so equipped. If, however, the cover still appears fastened at the point where the electric cord enters the set, it probably has the safety interlock. Take hold of the cover near where the cord seems fastened to it and pull straight off, gently agitating it from side to side to loosen the plug. Figure 4 shows an outline sketch of such an arrangement.

This safety interlock actually is a plug and a socket, respectively, riveted to the cover and to the chassis or the cabinet in such a fashion that removing the cover disconnects the electric cord from the set proper and renders it impossible to operate the set until the cover is replaced.

In replacing the cover, be sure to fit the plug and socket arrangement together properly and firmly before fastening the cover in place with screws. ALWAYS HAVE THE SET TURNED OFF AND THE CORD PULLED OUT OF THE ELECTRIC OUTLET WHEN REMOVING AND REPLACING THE REAR COVER.

In a few rare cases it may be necessary to make some adjustment behind a safety interlocked cover. If you should ever need to do this, the following procedure will point the way without bypassing the safety feature of the interlock.

At first, make a slight, experimental adjustment, being careful to note which way you turn the adjustment and how far it is turned. Then replace the rear cover, being careful to fit the interlock plug and socket together properly, and tem-

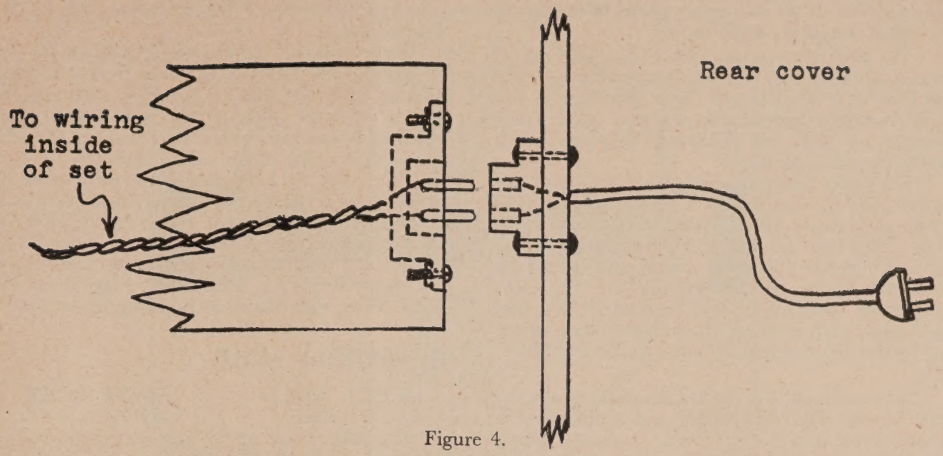


Figure 4.

porarily fasten the cover in place with one screw. Now put the electric plug in the receptacle and turn the set on. Note by the picture on the screen whether you made any improvement or not. If you did, but the improvement was insufficient, switch the set off, pull the plug out, and again remove the rear cover. Continue turning the adjustment in the same direction as before, then replace the back, put in the one screw, plug in the electric cord and turn the set on again for a test. Keep repeating this process until you are satisfied with your work. However, if your first experimental adjustment proved to be in the wrong direction as evidenced by checking the picture on the screen, then you should turn the adjustment in the opposite direction the second time you turn it. Though this procedure may appear tedious, it should not be necessary to perform except rarely, and it does allow one to make adjustments behind a safety panel without circumventing the safety precautions. The two precautions to keep in mind are to always have the set turned off and the plug removed from the receptacle when removing or replacing the rear cover, and always remember between adjustments just which way and how far the adjustment was turned.

In fact it is poor practise in general to pull the electric cord out of the outlet as a means of turning the set off. Always turn the set off with the ON-OFF switch before removing the plug from the electric outlet. Similarly, when ready to operate the set again, put the plug in the outlet first, then turn the set on.

Some sets do not have all the controls found on others. This is because of minor differences in the design of various models. It is believed that the scope of these instructions is sufficiently broad that you will be able with their help to make the fundamental adjustments on any make or model TV receiver.

If there are controls at the rear of the set which you cannot easily reach and still see the picture screen directly, you may need to place a mirror in such a position that you can see the reflection of the picture. An easy way to do this is to stand a small mirror on a chair, leaning it against the chair back and facing the picture screen so that you can see it plainly while standing or sitting behind the set. For convenience, the size of the mirror should be slightly larger than the picture screen, although any size will do if it allows you a view of the whole screen.

Never try to make adjustments with regular program material except in case of emergency, to keep the picture usable. For best results, wait until a test pattern is being broadcast to make such adjustments as picture size, centering, etc.

If your TV set has a FINE TUNING control, always adjust it for the best possible sound, and the picture will take care of itself if the receiver is operating normally. That is, with the main station selector set to the desired channel, slowly turn the FINE TUNING control back and forth until the sound is as loud and clear as the FINE TUNING control can get it, and the picture automatically will be in tune.

It probably is easier on both the eyes and the picture tube if the BRIGHTNESS and CONTRAST controls are operated just far enough advanced for pleasant viewing.

Most authorities agree that there should be at least a small light burning in the room while watching programs. Experiment with various placements of a table or floor lamp so that it does not shine directly in your eyes and—(this is important)—you do not see the reflection of the lamp in the picture screen.

In connection with the last two paragraphs, if there is any doubt in your mind, and also in the matter of the use of the various filters for reduction of glare, consult an eye doctor or your family physician. You definitely should do so if

any member of the family complains of headaches or eye strain after long viewing.

The first three controls to be discussed are so commonly used that it is possible you may already be somewhat familiar with them. However, if you will read these instructions, you may glean a new insight into their use which will help you secure better results with them.

For easier understanding by all concerned, the names for the controls as they are discussed in these paragraphs will be stated in complete wording rather than the abbreviations often used on sets. As stated previously, some controls go by different names on different makes. The most commonly used names will be used in this text and under each heading will be listed other names and some abbreviations which may be encountered.

It is assumed that the reader understands the use of the BRIGHTNESS and CONTRAST (sometimes called PICTURE) controls. However, if you are tuning a television receiver for the first time, it might be pointed out that these two controls must be used together, that is, adjust first one, then the other until the contrast between the blackest portions of the picture and the whitest portions is pleasant to the eyes. If, when you first turn the set on there is nothing at all on the screen, turn the BRIGHTNESS full on and the CONTRAST or PICTURE control also full on and then as you begin to receive a picture, gradually back off both controls, going from one to the other until the desired qualities of grays, black and white are secured.

(2) HORIZONTAL HOLD

HORIZONTAL	HOR. HOLD
HORIZ.	HORIZONTAL SPEED
HOR.	HORIZ. SPEED
HORIZ. HOLD	HOR. SPEED

If the picture is so torn apart as to be unrecognizable as a picture, leaving the screen covered with gray streaks, slightly diagonal in direction, the HORIZONTAL HOLD probably is out of adjustment.

Making sure the CONTRAST or PICTURE control is turned sufficiently high that the screen shows gray streaks and not pure white, rotate the HORIZONTAL HOLD control back and forth from one extreme to the other until the picture appears to form or more or less fall into place.

Occasionally a user may confuse the need for a HORIZONTAL HOLD adjustment and the need for a VERTICAL HOLD adjustment, so if the picture does not shape up with the HORIZONTAL HOLD, try rotating the VERTICAL HOLD control also.

When a picture has formed on the screen, rotate the HORIZONTAL HOLD back and forth slowly. If the set is operating correctly the picture should hold in place over a rather wide range of the control. There are two effects you may notice:

1. There may be a slight centering effect, that is, by turning the HORIZONTAL HOLD a small amount from one side to the other, you may be able to move the entire picture from side to side; needless to say, you will wish to leave it set with the picture in the center of the screen;
2. There may be a bit of a flicker or a trace of breaking up of the picture, usually near the top or bottom of the screen as the HORIZONTAL HOLD is moved from one side to the other. Your picture will hold in place best if the final setting of HORIZONTAL HOLD is away from the point where this flicker or breaking up occurs.

(3) VERTICAL HOLD

VERT. HOLD	FRAME LOCK
VERTICAL	VERT.

The appearance of the picture on the screen when the VERTICAL HOLD is out of adjustment is something like having a series of identical photographs mounted one above the other on an endless belt moving either up or down past the viewing screen. The further the VERTICAL HOLD control is from its correct setting the faster will be the movement of the pictures. Also, by experimenting with this control one can observe that starting with the correct setting, that is, when the picture is locked in place on the screen, turning the VERTICAL HOLD in one direction will cause the picture to move upward on the screen, while turning it the other way will cause the picture to move downward on the screen.

Continuing you will probably note that in one direction or the other, the movement of the picture will be much more rapid than in the opposite direction. For example, with some TV sets, turning the control so that the picture begins to move upward, the movement will be very slow to start with, then faster and faster as the control is turned more and more. Backing the control up in the other direction, when the picture starts to roll downward on the screen, the movement immediately will be very fast. But on other sets, the picture movement upward may be rapid, and downward be very slow at the start.

In most cases, the proper setting for the VERTICAL HOLD is secured by deliberately turning it in the direction where the picture rolls slowly whether that is up or down, then gradually bringing the control toward the locked-in position so that the picture movement is slower and slower, finally coming to rest. Then turn the VERTICAL HOLD control just a little more in the same direction.

In other words, when using the VERTICAL HOLD control, try to approach the correct setting from the direction in which the picture movement is slow. It has been the author's experience that most sets will stay locked in vertically when adjusted in this manner.

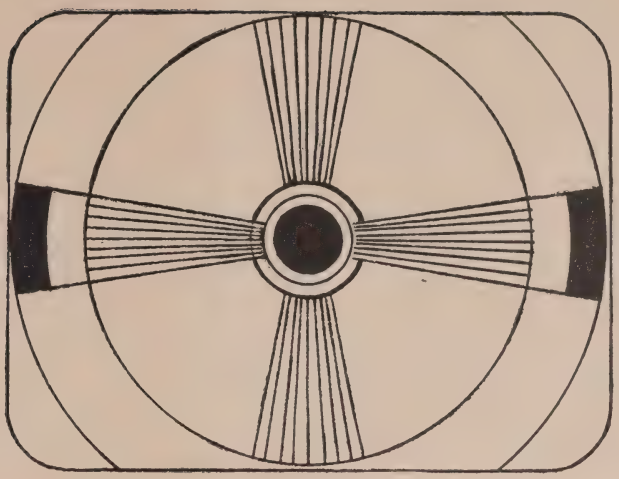


Figure 5.

(4) FOCUS

Hardly anyone will fail to recognize a picture which is out of focus. It is blurred, fuzzy, and indistinct. Most everyone has seen a photograph at one time or another which was taken with the camera out of focus. A TV set which is not focused properly provides the same kind of a picture.

Turning the FOCUS control back and forth should readily bring the picture into proper focus, but there is a little trick to really sharp focusing which you might not know about.

If you examine a picture closely, you will see many fine lines running horizontally across the screen. These are called scanning lines and are the structure on which the picture is built. You need not count them; there are five hundred twenty-five.

If you will adjust the FOCUS control slowly and carefully while watching these scanning lines rather than the picture itself, and settle on the adjustment which leaves the lines as sharp and distinct as possible you will find that the picture is in the best focus also.

Incidentally, you will probably derive the most enjoyment from televiewing if you sit just far enough away from the screen that you cannot see these lines. This is the same principle as looking at a fine painting. One must stand far enough back that the brush marks are not discernible.

(5) THE TEST PATTERN

Figures 5 and 6 show the two most commonly used test patterns, properly centered and adjusted for correct size and linearity. If linearity is a new term to you, it is pronounced to rhyme with tinny-air-i-ty, with the accent on the syllable air. Broadly speaking it means symmetry or proportion. A picture in which all objects and persons' figures are well proportioned and normally shaped is said to have good linearity. This will be more fully explained when the operation of the LINEARITY controls is discussed.

In the case of figure 5, you will note that there are two rather large circles. The purpose of the outside circle is to secure proper width of the picture; this circle should just touch the sides of the picture frame, or mask as it is called by most manufacturers. Referring to the frame or mask is simply speaking of the space on the panel of the set in which the picture appears. The inside circle is used to adjust the height of the picture. The upper and lower extremities of the inside circle should just touch the top and bottom of the picture frame.

With test patterns such as figure 6, having only one large circle, adjustments must be made so the upper and lower portions of this circle exactly fit into the top and bottom of the picture frame. The four smaller circles at the corners should exactly fit into the picture frame corners. Best results usually can be secured from the pattern with the two large circles, shown in figure 5. It has been the general practise of most stations to transmit test patterns for several hours during the day before beginning their regular program transmission.

During the time a station is broadcasting test pattern, the audio portion of their broadcast (the sound heard in the speaker) may take one of three forms: A. Music; B. Steady tone; C. No sound at all. So if during this time you can hear no sound, do not assume immediately that there is something wrong with your set. Wait until

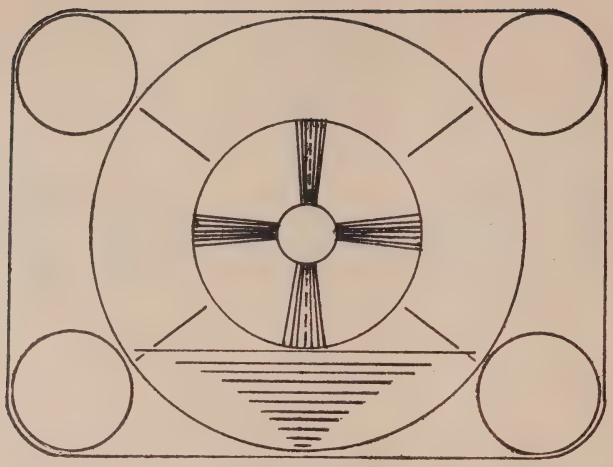


Figure 6.

regular program comes on, or try another station; if you then hear sound, you can assume the station was not transmitting any sound with their test pattern.

In speaking of a television transmission, the part of the signal which is seen on the picture screen is called video, and the part you hear in the speaker is called audio or simply sound.

Special Note to Those with a Circular Screen

If your set has a circular screen, it should have a switch with which you can make the picture either normal (small) in size, or blown up (large). In the latter position, the picture will entirely fill the circular screen. In making adjustments for size, centering, etc., you should set this switch for the normal (small) size. This will be further discussed under WIDTH and HEIGHT adjustments.

(6) WIDTH

HORIZONTAL SIZE HORIZ. SIZE
HOR. SIZE PICTURE SIZE

If the sides of a picture extend beyond the side margins of the picture frame so that portions of the sides are lost to view, as in figure 7, the picture is too wide, and should be reduced by an adjustment of the WIDTH (HORIZONTAL

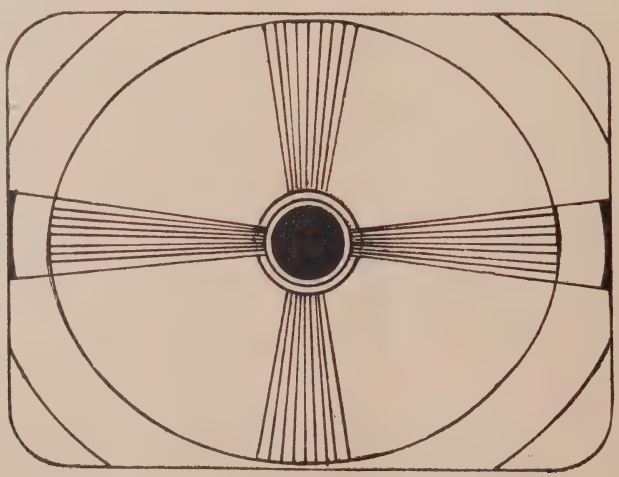


Figure 7.

SIZE) control. On the other hand, if the sides of the picture do not quite reach the side margins of the picture frame, the picture is not wide enough. This also can be corrected by an adjustment of the WIDTH control. Remember, when the word WIDTH is used, you may consider it identical with HORIZONTAL SIZE, or PICTURE SIZE, if your set has one of those controls in place of the WIDTH control. In the case of a picture being not wide enough, there will be a very dark space at the sides of the picture; the picture will be complete, but it simply does not fill the screen space.

Turn the width control one direction and the picture should get wider, and turn it the other direction for reducing the picture width.

There are three kinds of width controls in common use. Two are screw driver controls, the first type of which can be turned less than one revolution, while the second type is the threaded end of a long screw with no screw head, but slotted for a screw driver. This second type can sometimes be turned through several revolutions before noting any great change in the width of the picture. These two types are shown in sketch form in Figure 8. The third type is a sliding wire or shaft. It is adjusted by sliding it along a slot cut into the chassis.

There may be times when a simple touching up of the WIDTH control will make the picture just the right width, and still leave the circles in the test pattern looking like real circles. However, there also will be occasions when although adjusting the WIDTH control will make the picture wide enough, in addition, it will cause the large circle in the center of the test pattern to look more like an egg lying on its side.

When this happens, you will need to adjust also the HORIZONTAL LINEARITY control. In fact, it is virtually impossible to divorce these two controls completely.

The proper procedure at such a time is to work back and forth between the two controls, operating first one, then the other, gradually working the test pattern circles toward the proper width, all the while attempting to keep them as round as possible. This operation will be further explained in the section titled HORIZONTAL LINEARITY.

It should be pointed out that there comes a time when the circles cannot be made perfectly round, but for practical purposes you can tolerate slight variations from the ideal test pattern shapes, as they probably will be so small as to cause no noticeable reduction in picture quality on regular program reception. It is entirely up to the individual, for just how much perfection he wishes to strive in making adjustments. When you feel you have done as well as you can, there is a good chance that when you tune in a regular program you will be pleased with your work.

Note: With those receivers having a circular screen, remember that the switch should be in position for a normal, reduced-height picture, when making any of these adjustments. Figure 9 shows a test pattern on a circular screen with the switch in the normal size position. It is impractical to attempt adjustments with the picture in the blown up condition.

Important: A few sets have been manufactured without any control called HORIZONTAL SIZE, PICTURE SIZE, or WIDTH, but having a control labeled:

HORIZONTAL DRIVE, HORIZ. DRIVE, or HOR. DR.

On such receivers, try using this control for adjusting the width of the picture. Do not use the DRIVE control for this purpose unless your set definitely has no WIDTH, HORIZONTAL SIZE, or PICTURE SIZE control. The use of the HORIZONTAL DRIVE control on sets which have one in addition to one of the regular "width" controls will be discussed at a later time.

Note During or after WIDTH adjustments, the picture may seem to have moved over to one side of the screen or the other, usually by only a fraction of an inch. If it does this to a great enough degree to be annoying, see CENTERING section.

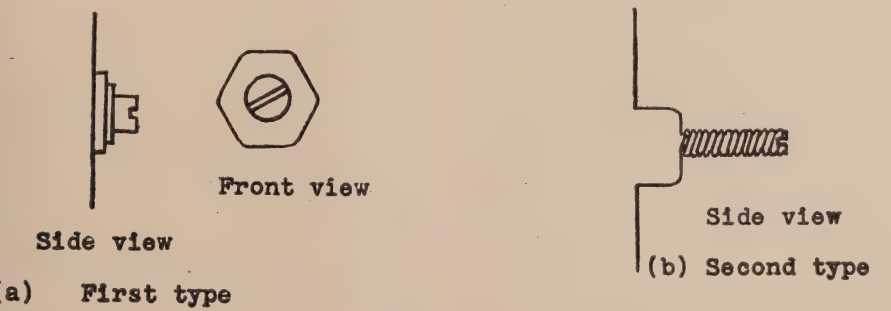


Figure 8.

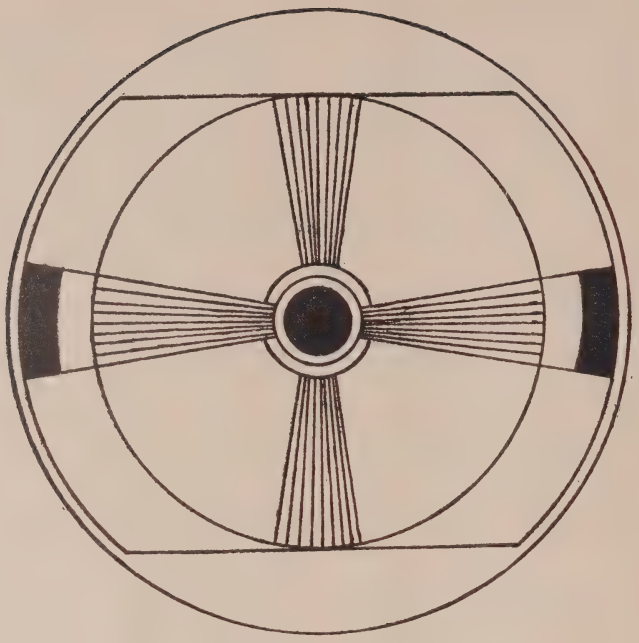


Figure 9.

(7) HORIZONTAL LINEARITY

HORIZ. LINEARITY HORIZ. LIN.
HOR. LIN. HOR. LINEARITY

When watching a regular program broadcast, if objects and persons' figures seem stretched or elongated abnormally in a horizontal direction, the receiver is said to have poor HORIZONTAL LINEARITY. For example, a person's position on the screen might be such that one side of his head appears to bulge out. Actors' or dancers' arms when outstretched, may seem to stretch to unusual lengths.

When a set in this condition is tuned to a test pattern, you will see that what is supposed to be a large circle in the pattern looks more like a large egg, lying on its side. See figure 10.

Many TV sets have a control called very appropriately, HORIZONTAL LINEARITY, with which to correct this fault. Since a great number of TV receivers do have the control named HORIZONTAL LINEARITY, adjustment for this fault will first be discussed using the term HORIZONTAL LINEARITY, then other controls will be mentioned which can serve the same purpose.

Note: Mechanically speaking, there are two types of HORIZONTAL LINEARITY controls exactly like the two types of WIDTH controls discussed previously. For complete explanation please refer back to the section WIDTH.

Turn the HORIZONTAL LINEARITY control first one way, then the other way if necessary, while observing the effect on the size and shape of the test pattern. When the elongated portion of the circle begins to draw in toward the proper circular shape, you may be immediately satisfied with the result. On the other hand, it may be that though the pattern is now more nearly circular in shape, the picture may be too narrow to properly fill the screen space. If this happens, you will need to readjust the WIDTH control.

In dealing with the two controls, WIDTH and HORIZONTAL LINEARITY, the primary lesson to learn is to never give up. Try increasing the width with one of them and then reducing the width with the other one. Then try increasing the width with the second one and decreasing the width with the first one. Keep going back and forth between the two and by experience you will learn which one you need to turn first in order to gain the desired results. Be assured, your patience here will be rewarded.

As mentioned previously, slight variations from a true circular pattern can be tolerated and not make any great difference on regular program material. When you have the pattern as near to truly circular as possible, if you will then wait

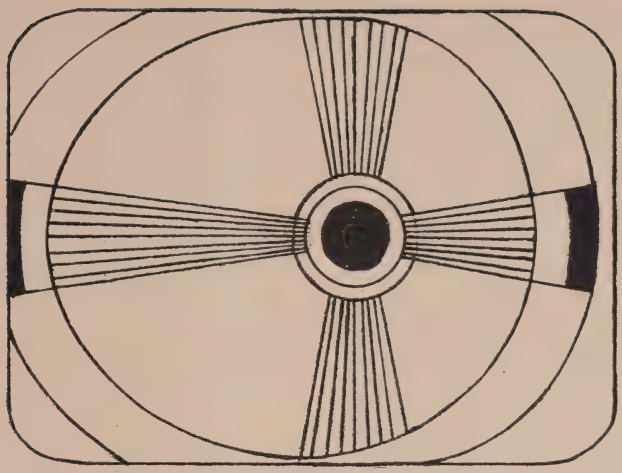


Figure 10. Poor HORIZONTAL LINEARITY

until regular programs are being broadcast, it is possible you will be quite satisfied with results. Remember, though, do not attempt any fine point adjustments during the regular programs.

Note: During or after linearity adjustments, it is possible that you will see the need for re-centering the picture, that is, the whole picture may seem to become shifted slightly to one side or the other on the screen. See HORIZONTAL CENTERING.

Horizontal Drive

If you are unable to locate on your set a HORIZONTAL LINEARITY control, but do find one called HORIZONTAL DRIVE, which may be abbreviated HORIZ. DRIVE, HORIZ. DR., or HOR. DR., it may be used for the same purposes as you would use the HORIZONTAL LINEARITY control.

When adjusting the HORIZONTAL DRIVE control for the purpose of improving the circular shape of a test pattern, keep a close watch on the screen to see if it makes the overall picture any brighter. If so, do not turn it any further in this direction than absolutely necessary.

Some TV receivers have both HORIZONTAL LINEARITY and HORIZONTAL DRIVE controls. With one of these receivers, make every effort to correct the linearity (shape) of the pattern with the LINEARITY control before disturbing the DRIVE control. Then if it is still necessary, make small adjustments with the HORIZONTAL DRIVE control along with further small adjustments with the HORIZONTAL LINEARITY control. As stated above, avoid turning the HORIZONTAL DRIVE control if it makes the picture brighter. If, however, turning the HORIZONTAL DRIVE makes the picture slightly dimmer, this is all right.

Keep ever in mind the admonition to use patience when adjusting more than one control at a time. Turn each control by small amounts and go back and forth from one to the other often, and your patience will be rewarded. If you are tempted to be discouraged, return the controls to their original positions and start over.

Horizontal Peaking

If in addition to the HORIZONTAL LINEARITY control, your set has a control called HORIZONTAL PEAKING, as a last resort only, try adjusting it for improvement in the roundness of the test pattern. If it makes no improvement, return it to its former position.

Horizontal Balance

Treat the HORIZONTAL BALANCE control the same as the HORIZONTAL PEAKING. As a last resort only, adjusting it may improve the pattern roundness; if not, return it to its original position.

Make it a rule to return any control to its former setting if it does not make a desired improvement.

In general, it usually is the preferred procedure to increase the width of a picture with a WIDTH or HORIZONTAL SIZE control, and then, if necessary, correct the shape with the LINEARITY control or one of the controls mentioned which may work the same as it does.

To make this idea plainer, consider a possible condition. Assume that the picture is not wide enough to fill the screen. First turn the WIDTH or HORIZONTAL SIZE in whichever direction necessary to make the picture wider. Now it may be wide enough, but it may have become slightly egg shaped. Turn the HORIZONTAL LIN-

EARITY or whichever corresponding control your set has, in the direction necessary to bring the shape back to more nearly circular. Now it again may be too narrow; again increase the width with the WIDTH control, and if the pattern becomes egg shaped once more, return to the LINEARITY or other corresponding control to reduce the egg shape to the circular. Patiently keeping up this procedure eventually should lead to a picture which is of the correct width and at the same time properly shaped.

(8) HORIZONTAL CENTERING

HORIZ. CENTERING
HORIZ. CENT. HOR. CENT.
HORIZONTAL POSITION
HORIZ. POS. HORIZ. POS.

If there is a blank space on one side of the screen, and a portion of the picture is completely lost on the other side due to entire picture being literally shifted to one side, it is said to be not centered, horizontally. See figure 11.

Many television sets have a control for correcting this fault called HORIZONTAL CENTERING or HORIZONTAL POSITION. If your set has one or the other, it is a simple matter to keep the picture in the exact center of the screen. Simply turn the control one way and you can observe the whole picture move across the screen. If the first way you turn it causes the picture to move the wrong direction, turn it the other way until the picture is exactly centered.

All commonly used test patterns have a small circular portion in their very center. It is always a good idea to adjust the centering (when necessary) in order that this small target is in the exact center of the screen. Then, if the outer circles do not fall in their prescribed positions, it is indicated that adjustments of size and linearity are needed.

Another type of centering control is a lever extending through the back cover of the set. Moving this lever around will center the picture. If you cannot locate one of these readily accessible controls, then another, more difficult method has evidently been provided.

This other method of centering a picture is by means of an actual mechanical adjustment of a piece of apparatus called the focus coil. The focus coil is one of the collar-shaped pieces around the neck of the picture tube.

The average TV set owner may not wish to make this kind of centering adjustment for himself, or at least not without first watching some experienced person do it. For those who wish to learn to perform this particular operation, probably through watching someone else at least one time, then next time doing it himself, the following explanation will furnish a knowledge of what is going on.

Figure 12 shows the location of the focus coil and gives an idea of its size and shape with respect to the picture tube. Since the tube and the focus coil look the same from side or top, the drawing assumes either a downward view or a side view. There are, of course, other collar-shaped pieces of apparatus around the neck of the picture tube, but for this explanation we can ignore them. In looking at a picture tube in a set from the rear, the first large collar-shaped piece you see around the tube neck is the focus coil. There may or may not be a smaller close-fitting collar nearer the rear end of the tube, but you can recognize it as not being the focus coil by its

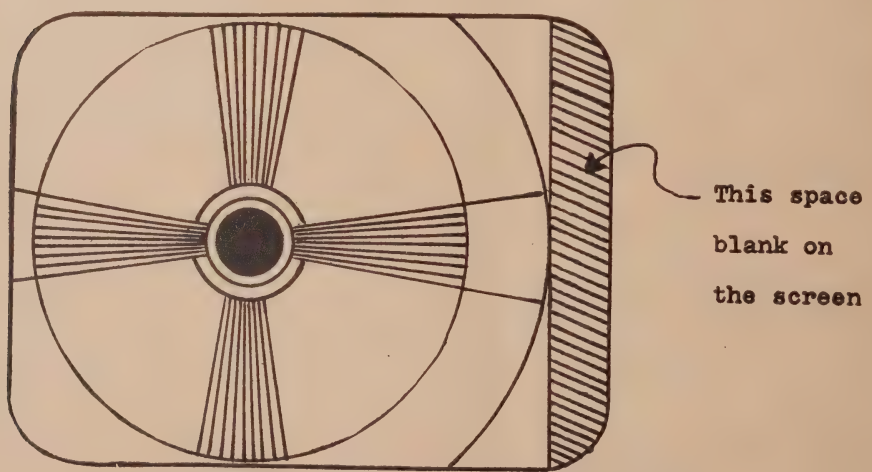


Figure 11. Not properly CENTERED, HORIZONTALLY

small size, and the fact that it fits quite tightly around the tube neck. The focus coil may be round, or square with rounded corners, when looking at it from the rear. In any case it will be at least three or four inches across. It may be mounted separately or as part of an assembly with other pieces, and fastened on a common frame with them. Incidentally, the other apparatus mentioned in this connection is the pair of deflection yokes.

Whether the focus coil is mounted separately, or on a common bracket with the deflection yokes, a provision of some kind is made to allow it to be tilted to various angles. It may be mounted in a sort of saddle mounting bracket, with thumb screws or wing nuts to hold it in position. When it is necessary to make adjustments on it, the thumb screws or wing nuts are loosened, and the focus coil tilted to cause the picture to move its position on the screen, either up, down, or across to one side or the other. The thumb screws or wing nuts are then tightened to hold the focus coil rigidly in place. The amount of tilting action possible is limited by the fact that the focus coil is around the neck of the picture tube like a collar, and if moved too far can press against the glass, an undesirable situation. This arrangement is shown in elementary form in figure 13.

Another method, often employed, is that of mounting the focus coil by means of three or four screws, behind which are coil springs allowing for considerable movement on all sides. Turning these screws performs the tilting action necessary to move the picture to different positions on the screen. This is illustrated in skeleton form in figure 14.

Still another arrangement provides two brackets on opposite sides of the focus coil as shown in figure 15, held in place by a screw in each bracket. By loosening both screws slightly, the brackets can be moved about somewhat, causing the picture to shift its position on the screen. When one is satisfied with the picture's position, the screws are again tightened.

At least two makes of TV receivers have what are called centering rings, one just in front of, and another just behind, the focus coil. Moving these rings around in a circular fashion, much in the manner of turning a ring around on your finger, causes the picture to be across and up and down on the screen.

The action of the focus coil in moving the picture about, to different positions on the screen can be likened to pointing the nozzle of a hose with which one sprays water. Imagine for a minute that you are holding in your hand the nozzle of a garden hose and have the water stream adjusted to a fairly broad spray. Consider further, that you are pointing it toward a wall. Now if you had a block of wood about three or four inches across, and about an inch thick, with a hole bored through its center, and the nozzle fit into this hole, you can visualize what would happen to the stream of water as you tilt the block back and forth so that it faces slightly different angles. The stream of water will be striking the wall at various positions depending upon the direction the block is facing.

The spray of water can be compared to the stream of electrons headed toward the face of the picture tube, and the block of wood represents the focus coil. As this sprayed stream of electrons strikes the picture tube screen they cause the picture to appear thereon, and as the focus coil is tilted so that it faces the screen at slightly different angles it will cause the spray of electrons to strike the screen at different positions.

If you are wondering why it is called a focus coil if it is used for centering the picture, the answer is simple. It does focus the picture, but you might say by remote control. Wires run from it down into the set proper and are connected to the FOCUS control and other parts of the set.

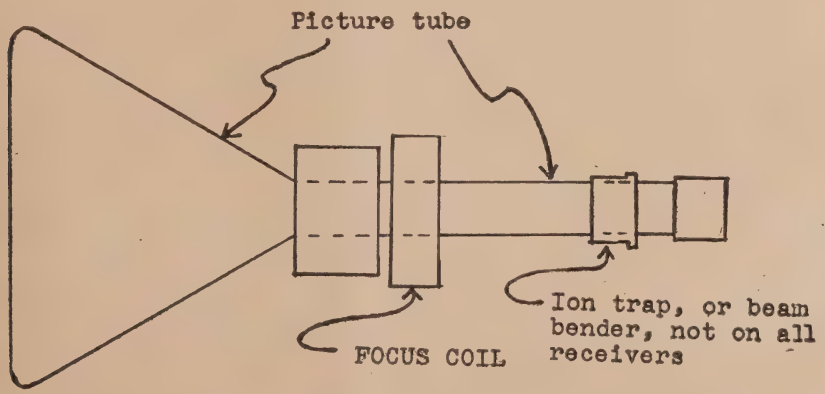


Figure 12. Side View

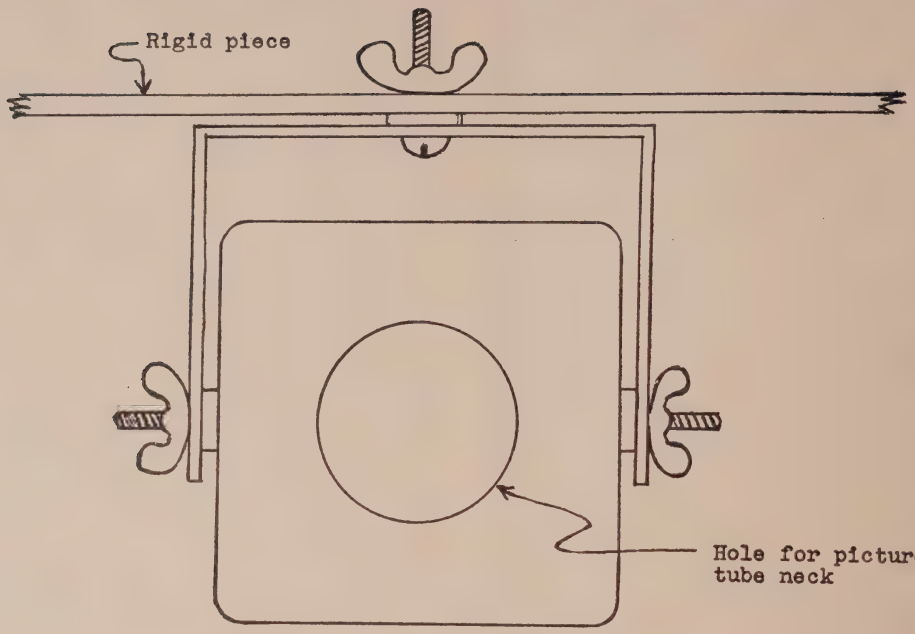


Figure 13. Focus coil viewed from rear of set

Turning the FOCUS control changes the electric current through the focus coil to accomplish focusing.

Note, that although this discussion has been under the heading of HORIZONTAL CENTERING, any TV receiver which requires this method of centering a picture horizontally, requires it also for VERTICAL CENTERING.

If your TV set has no easy, convenient way to control centering, such as a screw driver adjustment, and requires the more complicated method just described, you may be willing at times to tolerate a slight off-center condition if it isn't bad enough to prevent enjoyment of the picture. Then at some convenient time, observe someone perform the operation, and next time you may be able to do so, knowing from the above description what it is you are doing. Also you will know from these instructions that the adjustment must not be done too far in any one direction, due to possibly pressing against the glass neck of the picture tube. In this connection, when it must be done by means of the adjustment screws shown in figure 14, if turning any given screw a few turns does not seem to accomplish the desired result, back it up a turn or two and try one of the others; avoid turning any one screw too far, and if any one of them seems to bind, stop and back it off a turn or two.

Within certain limits, turning the HORIZONTAL HOLD control one way or the other will sometimes, though not always, move the picture back and forth a short distance across the screen. This, of course, is not its primary function, but on occasions it may serve to move the picture back and forth by a small amount.

(9) HEIGHT

VERTICAL SIZE VERT. SIZE
PICTURE HEIGHT PIC. HEIGHT

If there is a blank space at the top and bottom of the picture screen, due to the picture being too short, or if the picture extends beyond the upper and lower borders of the screen, then there is need for adjustment of the HEIGHT, PICTURE HEIGHT, or VERTICAL SIZE control, whichever one your set has; all three of these control names mean exactly the same thing. See figure 16.

Turn the control first one way, then the other, if necessary, to make the picture fit exactly into the screen space vertically. As with other adjustments, this should be done when a test pattern is being shown, if at all possible.

Having corrected the height of the picture, especially if you have increased it, the shape may now assume that of an egg standing on end, rather than a true circle. If so, turn the VERTICAL LINEARITY control (see next section) as required to reduce this egg shape back toward the circular. You may need to go back and forth be-

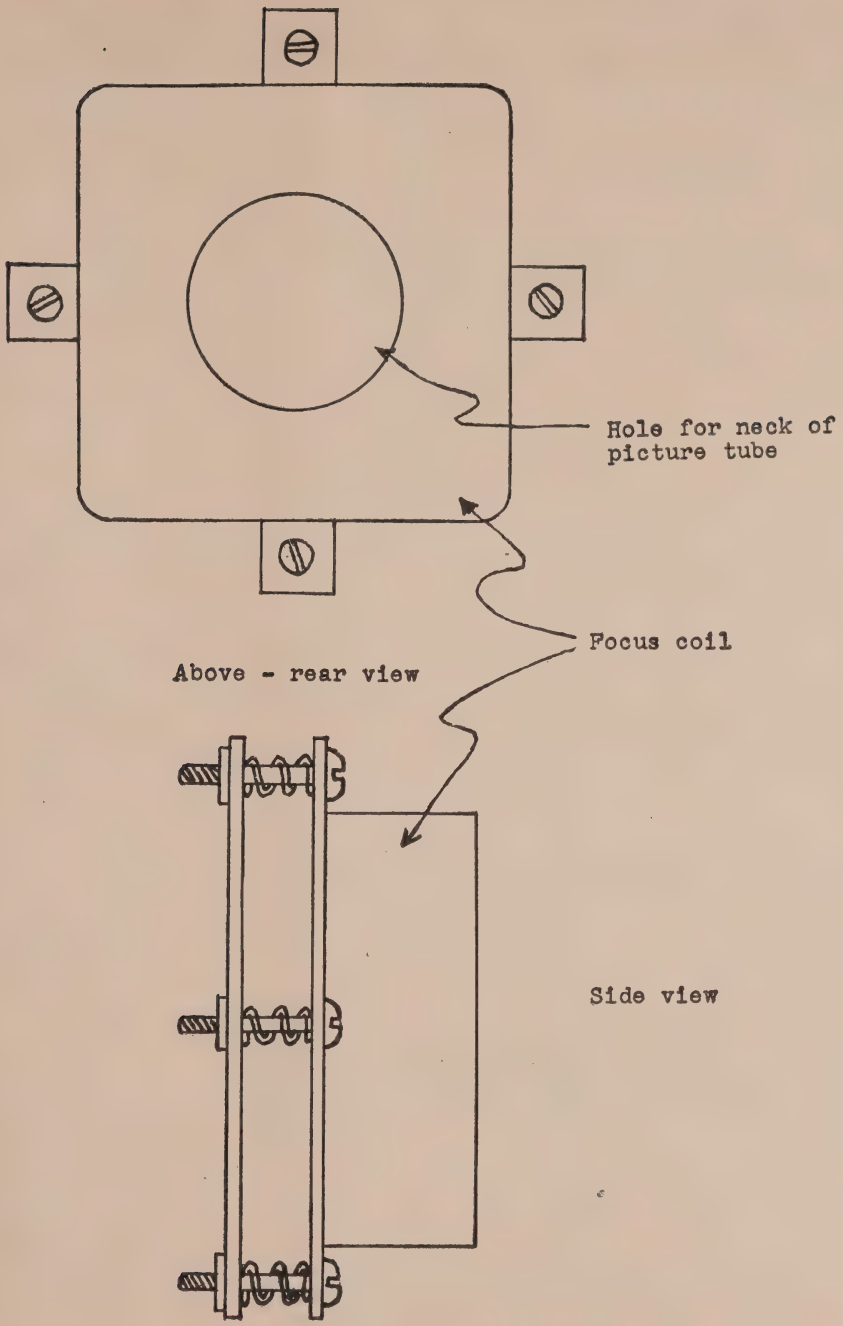


Figure 14. Showing rear and side views of one method for centering the picture

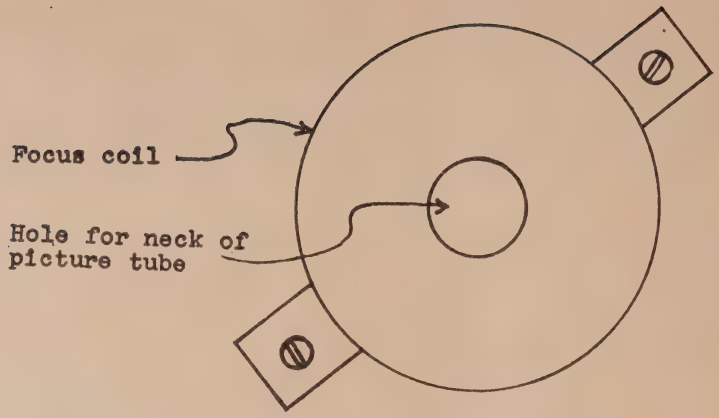


Figure 15. Another method for picture centering

tween the two controls several times in order to get the height correct and still eliminate the egg shape condition. As stated in connection with other adjustments, absolute perfection may not be reached, but it is probable that when you have secured the nearest approach to a true circular shape possible, you will be pleased with your work when viewing regular programs. Therefore it is wise, after you have done as well as you can, to wait until a program is on the air to observe the results of your labor. Do not, however, attempt any last touch-ups during regular programs; it is virtually impossible to adjust for proper linearity (shape) during program broadcasts.

You will observe that turning the linearity control one way will increase the size as well as aggravate the egg shape condition, while turning it the other way will decrease the size and improve the egg shape condition, that is, bring it down to more nearly a true circle. The usual procedure then, when a picture needs to have its height (vertical size) increased, is to increase it with the HEIGHT control and then reduce it slightly with the VERTICAL LINEARITY control, doing this again and again in small amounts, until the size is satisfactory and the shape is very near a circle. When necessary to reduce the picture's height, this usually can be done by the HEIGHT only. It usually isn't necessary to dis-

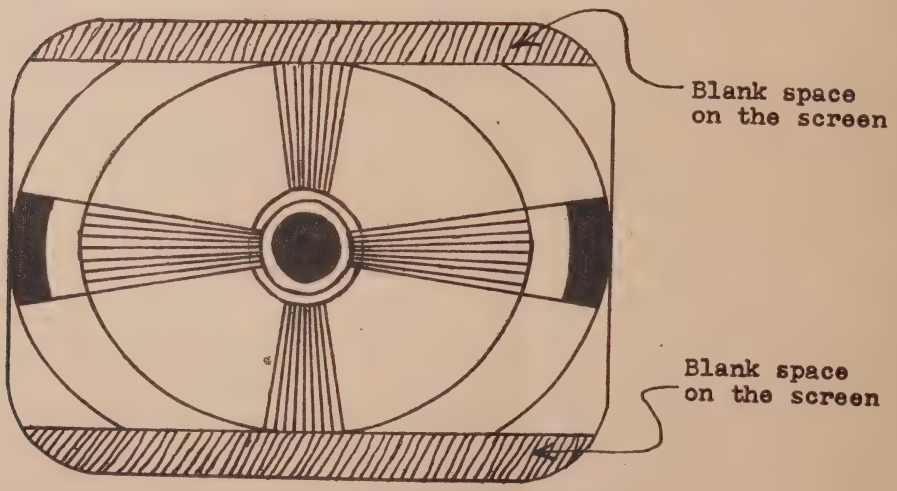


Figure 16. Insufficient HEIGHT

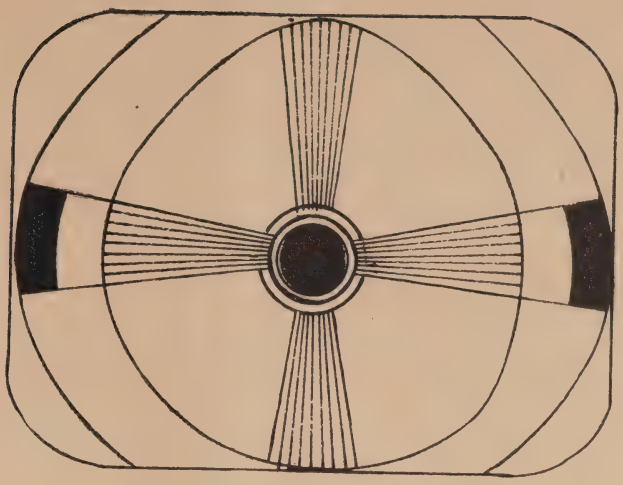


Figure 17. Poor VERTICAL LINEARITY

turb the LINEARITY control when reducing the size.

If You Have a Circular Screen

If you have one of the circular screens, the following suggestions will help you to properly adjust the HEIGHT of the picture.

In any event, it is necessary to set the switch with which you determine the size of the picture with respect to normal, or blown up size, to the normal position. This will make the test pattern look something like Figure 9.

There are two ways to adjust for the correct HEIGHT of the picture. The first and simpler is to adjust the HORIZONTAL SIZE or WIDTH to the correct degree, then to adjust the HEIGHT until the pattern is perfectly round, or as nearly so as you can possibly make it.

The other method is a bit more scientific, but not difficult. First make certain you are satisfied with the WIDTH of the picture, then take a ruler and measure the width. For example, let us say you find this to be 12". (Try to measure it accurately to the nearest quarter-inch).

Now take three-fourths of this width in inches, and adjust the height of the picture until it is three-fourths of the width.

In other words, the height of a properly adjusted picture is always three-fourths the width. For every 4" of width, there should be 3" of height.

In our example, for the width of 12", the height would of course be 9".

(10) VERTICAL LINEARITY

VERTICAL LIN. VERT. LIN.

During normal program broadcasts, if a person's legs seem extra long in comparison with the size of his head and upper portion of his body, or for that matter, if the upper and lower portions of any objects pictured seem out of proportion with each other, the vertical linearity is said to be poor.

When this condition exists, tuning in a test pattern doubtless will reveal that what is supposed to be a circle will look more like an egg standing on end, as illustrated in figure 17.

Turning the VERTICAL LINEARITY control one way or the other should reduce the effect. If the first way you turn it makes the situation even worse, stop and turn it the other way.

When the pattern has been reduced to more nearly a circular shape, it is quite possible that it will not be high enough in size to fill the screen vertically. In this case, turn the HEIGHT, PICTURE HEIGHT, or VERTICAL SIZE, whichever control your set provides, one way or the other as required to increase the height of the picture. If, as you do so, the circle again becomes like an egg on end, return to the VERTICAL LINEARITY control to bring it back toward the circular shape. If necessary, continue to adjust first one, then the other control until the pattern is close to being circular, and at the same time properly fills the picture frame vertically.

While making these adjustments, or after finishing them, if the entire picture seems too far up or down on the screen, it may need recentering. See VERTICAL CENTERING, the following section.

(11) VERTICAL CENTERING

VERTICAL POSITION VERTICAL CENT.
VERT. POSITION VERT. CENTERING
VERT. POS. VERT. CENT.

If the entire picture seems to have shifted its position up or down on the screen, so that you see a blank space at either the top or bottom of the picture, while at the other vertical extremity, a portion seems covered up by the picture frame (or mask), then the picture is not properly centered vertically. See figure 18.

The control called VERTICAL CENTERING, or VERTICAL POSITION, both of which mean precisely the same, can be turned one way to move the whole picture up on the screen, and the opposite way to shift the entire picture down.

If you are unable to find either of these controls, you probably have a receiver on which the focus coil must be mechanically adjusted in order to recenter the picture. Please refer to the latter part of the section HORIZONTAL CENTERING, since any set which uses focus coil adjustment for vertical centering requires the same thing for horizontal centering.

(12) SPECIAL ADJUSTMENTS

If your receiver has one or more of the following controls, this section will tell you what they are for and how to use them. Use these controls sparingly, that is, do not disturb any of them unless you feel there is a real need to do so.

1. HORIZONTAL LOCK
2. HORIZONTAL OSCILLATOR
3. HORIZONTAL FREQUENCY
4. HORIZONTAL OSCILLATOR FREQUENCY
5. HORIZONTAL A. F. C.

In identifying any of these controls on your set, remember that all or a part of any name may be abbreviated, such as HORIZ. for HORIZONTAL, OSC. for OSCILLATOR, or FREQ. for FREQUENCY. Incidentally, frequency is pronounced—freak wun see, with the accent on the syllable freak. Oscillator is pronounced—oss sill later, with a short "o" and accent on the first syllable.

If your receiver has none of these controls, it may be assumed that the set was so designed that they are not needed, so do not feel that something was left off when your set was made. But if you do find any of them, these instructions should prove of value in using it or them as the case may be.

The instructions for these controls as supplied to professional servicemen by manufacturers are often detailed and complex, and sometimes vary from one manufacturer to another, and for the very best possible reception those instructions are needed. However, you may feel that for economic reasons you cannot afford a service call every time an adjustment needs touching up, so to help you save money the following paragraphs are offered.

It is possible that some sets might have been manufactured with one of these five controls taking the place of what most manufacturers choose to call HORIZONTAL HOLD, HORIZONTAL SPEED, or simply HORIZONTAL. This is the control used to synchronize or pull the picture together, when it is literally torn apart horizontally. But, generally speaking, in the great majority of TV receivers which have any of these five special controls, their use is to assist the HORIZONTAL HOLD, HORIZONTAL SPEED, or HORIZONTAL control. This situation might even be termed literally controlling a control, for that is what it amounts to.

Before disturbing any of these five listed con-

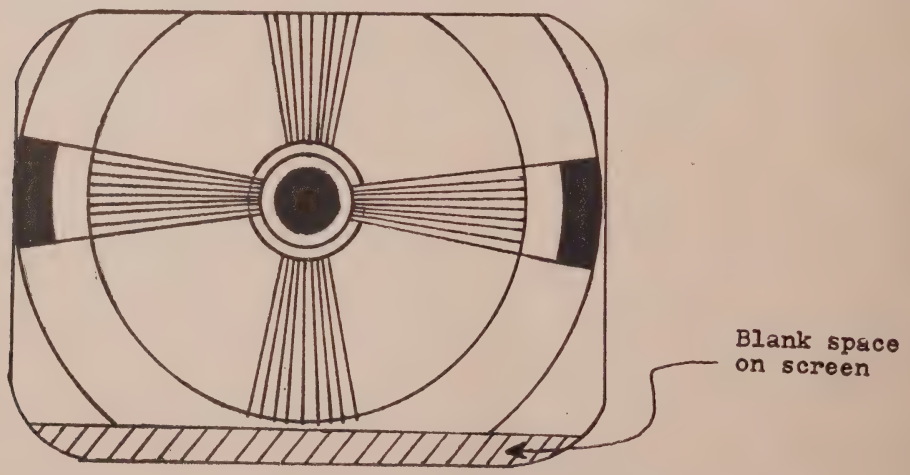


Figure 18. Improperly CENTERED, VERTICALLY

trols, be sure to conform to the suggestion headed, EXTREMELY IMPORTANT NOTE, near the beginning of this chapter, TELEVISION ADJUSTMENTS, regarding marking controls so they can be returned to their original settings should such be desired.

For simplicity, during the remainder of this section when the term HORIZONTAL HOLD is used, you can assume it to mean HORIZONTAL SPEED or just HORIZONTAL, if one of these is what is designated on your set; (on a great many sets, this control is on the front panel and is used frequently).

The need for any of these five special controls is shown when it becomes difficult to secure proper results when using the HORIZONTAL HOLD control. If the HORIZONTAL HOLD will not synchronize the picture at all, or if the picture does not seem to hold well without tearing apart after once getting the picture, the need for using one of these special controls is indicated. One other time which may show this need is when you can turn the HORIZONTAL HOLD only a very small amount one way or the other to have the picture begin to tear apart. Most manufacturers suggest that when you once have the HORIZONTAL HOLD adjusted for a picture, you should be able to turn it through a large part of its total range and still have the picture hold together.

Hence if you reach the point where you are dissatisfied with the operation of the HORIZONTAL HOLD control, and your receiver is equipped with any of these special controls, there are two methods by which you may improve the situation.

1. If the HORIZONTAL HOLD will synchronize the picture, but will not hold it in place satisfactorily while moving the control back and forth a considerable amount, this method may help. Set the HORIZONTAL HOLD so the picture is tuned in or synchronized and further, set the control about half-way between the two points where the picture begins to tear apart. In other words, after adjusting HORIZONTAL HOLD for the picture, turn it one way until the picture starts to tear apart, then turn it the opposite way until the picture starts to slip or tear apart again; half-way between these two spots on the control is where you should leave it for the following adjustments of any of the special controls. Turn the special control (any of the five listed) a small amount in either direction. Now try the HORIZONTAL HOLD again and see if it works any better. If not, go back to the special control and turn it back the other way a small amount. Again try the HORIZONTAL HOLD. If it does not work any better, keep this procedure up, moving the special control farther and farther each way, each time trying the HORIZONTAL HOLD control to ascertain if its operation is any better.

If your set is equipped with more than one of the special controls, return the first one to its original position and experiment with another one in the same way. Do not be afraid to keep experimenting with any of the five special controls as long as you have them all marked so you can return them to their original settings whenever you feel the over-all operation has not been improved.

2. If the HORIZONTAL HOLD control will not synchronize the picture at all, try the following procedure. Set the HORIZONTAL HOLD control about midway between its two extreme stops. To find this position, turn it one way until it stops, then turn it the other way until it stops; now set it about half-way between these two positions. Having done his, if your set has only one of the five special controls, turn it gradually back and forth through its entire range, observing the screen to see if the picture synchronizes or falls into place. If it does, leave this control for a moment and try adjusting the HORIZONTAL HOLD control to see if it operates satisfactorily. If it does, well and good, but if not, refer back to the beginning of method No. 1, above, and follow it through.

If your TV set has more than one of the special controls, set the HORIZONTAL HOLD to its mid-point as in the above paragraph, then proceed in this manner. Assume you have two special controls out of the five. Call them A and B for explanation purposes. Now, move A a small amount from its normal setting, then move B back and forth slowly while watching the screen to see if the picture "synchronizes." If it does not, go back to A and move it a little farther from its normal setting. Again try moving B back and forth, watching the screen for possible results. Keep this up, moving A farther and farther from its original setting, first one way then the other, always by small amounts, and between times, rotate B back and forth. Anytime the picture "synchronizes," leave A and B for a moment and try the HORIZONTAL HOLD to determine if it operates properly. If it does, you can consider your job done; if not, start at the beginning of method 1. above, and follow it through. A few TV sets have been manufactured with as many as three of these five special controls. If yours happens to be one of them, and there develops the need to adjust them due to improper operation of the HORIZONTAL HOLD control, follow the same general idea as just described for two controls, except that you will need to go back and forth between all three, moving each a little bit at a time, and watching the screen during each adjustment. Do not be afraid to experiment with these special controls provided that you have them marked so you can return them to their original setting at any time you feel results are not forthcoming.

In fact, after you have been adjusting more than one control as a part of one operation for a time, and feel that you are not meeting with success, it is a good idea to return all controls

to where they were originally and begin all over again.

As added precaution, it might be stated again, do not disturb any of these five listed special controls as long as the HORIZONTAL HOLD control operates properly.

Another word of warning of something to avoid—when making repeated adjustments, especially where more than one control is involved, an easy error to make is to reach for an entirely wrong control sometime during the process. So to be on the safe side, make it a rule to pause just an instant before turning any adjustment and say over in your mind, "Is this the control I want to adjust?" Having reassured yourself, go ahead.

In fact, this last word of warning is another excellent reason for marking controls; if you get on the wrong one, the error can always be corrected easily. If you do make a mistake and turn a wrong control, simply return it to its former setting and go ahead. If, during adjustments, the picture goes hay-wire and you are not sure what control you adjusted wrongly and unintentionally, return all controls to their normal positions according to your markings.

If repeated experimentation on any of the special controls does not make the HORIZONTAL HOLD control work correctly, it may be that there is a breakdown of some internal component of the TV receiver.

Whenever there have been changes made in the adjustments on a set, causing improved and satisfactory operation, it is wise to erase your pencil markings from the set chassis, and make new ones corresponding to the new settings. It is not necessary to make any new marks on the controls themselves.

(13) ION TRAP, OR BEAM BENDER

In figure 12, a small close fitting collar-like piece of apparatus can be seen near the extreme rear end of the picture tube neck. Not all sets have one, but probably the majority do. Do not disturb if the picture on the screen is uniformly bright over all portions of the screen, and if the picture is quite bright. If this collar, called the ion trap or the beam bender, becomes moved from its correct position, either a portion of or the entire screen will become darkened, depending on how far from its correct position it is moved.

As stated above, it should be left alone unless you have reason to believe that it may have been moved since the set was originally adjusted for a good picture. However, if by accident it does get misadjusted, here is how to readjust it properly.

Get in position to be able to observe the screen while at the same time being able to move the ion trap with your hand. Of course, you may need to use a mirror.

Now slowly turn the ion trap around, like turning a ring on your finger, first one direction, then the other, until the screen is uniformly bright over all portions. Also move the ion trap back and forth, by fractions of an inch until the picture is at its brightest.

During this operation, you should have a picture adjusted to a reasonably bright degree, using the normal controls for this purpose.

On sets which have a safety interlock arrangement on the rear cover, you will have to use the method described in the early part of this chapter, under the heading REMOVING THE REAR COVER. There, in detail, is described how to make adjustments behind this safety cover. It is necessary to keep taking the cover off and putting it back on, probably with only one screw to hold it in place, while making small adjustments each time. Each time you look at the picture, you can tell if your adjustment was helpful or not, and determine what the next trial should be.

CHAPTER II

FAILURES IN TELEVISION RECEIVERS

Safety First

For safety, never put your hand inside the cabinet unless the set is turned off and the electric plug pulled out of the receptacle. Also, if your set has a picture tube with a large metal cone for a back, it is possible to get a shock from it even after the set is turned off. After you have removed the electric plug, touch one end of a piece of wire to the set's metal chassis and the other end to this metal cone, momentarily, and after that no shock should result in touching it, until the set is turned on again.

(1) THIN WHITE LINE ACROSS THE SCREEN

If the situation develops, that all you can see on the picture screen is a thin white line running horizontally across the screen (with the BRIGHTNESS and PICTURE or CONTRAST controls turned full on), the trouble unmistakably is in what is called the vertical sweep circuit in the set. Among various makes and models of receivers there may be one, two, or perhaps three tubes in this circuit, any one of which may be burned out. The trouble is not always a burned-out tube, of course, but in a great many cases it is. Although possible, it is extremely unlikely that more than one tube will be burned out at one time.

Should this trouble occur in your receiver, leave it turned on for a few moments to allow all tubes plenty of time to warm up thoroughly. During this time, remove all but one of the screws which secure the rear cover on the cabinet. Then when you've turned the set off, and pulled the plug out of the receptacle, remove the last screw and the cover. Now proceed to feel all the tubes with your fingers. One tube may be almost cold to the touch, with all others being rather warm or even hot to the touch. If one is cold, compared to the others, it is probably burned out, and causing the trouble in question.

In the matter of removing the rear cover of the cabinet, this subject is discussed fully early in the section headed, TELEVISION ADJUSTMENTS.

If you haven't yet located a dead tube, there is still a chance that you can.

The most commonly used tubes which can cause this trouble bear the following identifying numbers:

6SN7 6SL7 6K6 6V6 6AR5 6J5
7F7 7N7 7AF7 7B5 6C4 6S4
6BF6 25L6 6W6 12BH7 6Y6 12AU7 12AT7

There may be others, of course, but these are used oftener by all manufacturers than any other tube types in the circuits where they can be the cause of this particular trouble.

On some part of the cabinet, usually pasted inside, or in any instruction booklet you may have received with your set, you may find a chart showing the type numbers and location of all tubes. Using the chart, if there is one with your receiver, for assistance, or without the chart if necessary, try to locate any of the above listed tubes which your set may have in it. The existence of several of these tubes in a set would not mean that all are definitely in a position to cause the trouble you are trying to locate, but since you have no way of knowing just which ones are, take note of all the tubes in the list which you can find in your receiver.

Now replace the back cover on the cabinet, put in one screw at the top to hold it temporarily in place and again turn the set on. Allow it to stay on a few moments, then turn it off, remove the electric plug, remove the rear cover, and again feel all tubes, paying particular attention to those in the above list. This double check may very well reveal one decidedly cooler than the others. If so, take this one to a store for testing.

If you are still undecided, you can remove all tubes in this list and take them to the store to have them tested. In the chapter headed, COMPLETE FAILURE IN A.C.-D.C. RECEIVERS, Section 5, there is a discussion on taking out several tubes at once and making certain you can replace them in their proper sockets. Reading that section at this time should give you ideas to use in the present situation. Since you cannot always reach into a television set to easily write tube numbers directly on the chassis in such cases, try this. Cut a piece of adhesive tape about 1" long x ½" wide for each tube to be removed where you cannot reach in to write directly on the chassis. Temporarily stick them on any clean, hard surface, such as a window sill or window glass. As a tube is removed, write the tube number on the adhesive tape, then peel the tape off from its temporary mooring, and stick it firmly beside the socket from which that tube was removed. Then when the time comes to put the tubes back in the set, using a flashlight if necessary, peer into the set and you have a sure guide as to where to put all tubes. After replacing all tubes, put the back cover on, replace the electric plug, and turn on the set. If you have replaced a burned-out tube, you should now be able to tune in a normal picture.

Important Note—Miniature Tubes

Miniature tubes, recognized by the fact that they are no larger than your finger, such as a 6C4 for example, require special handling. When

taking one out of its socket, pull straight up with very little side-to-side wiggling to loosen it. You can observe the tiny wires which it has for connecting prongs. Take care that they do not get bent. When reinstalling them in the socket, be sure by looking first at the tube base, then at the socket, that you have the tube turned right so the prongs fit properly in the holes, then push straight down, but do not force; if it doesn't go down readily, hold it up and look at the prongs again. If one is bent, you can usually bend it back parallel with the other prongs by a gentle push with any hard object. But do not bend any unless really necessary. Look again to be sure the tube is turned to the correct position so that the prongs fit into the socket. Figure 19 shows a tube of this type and its socket.

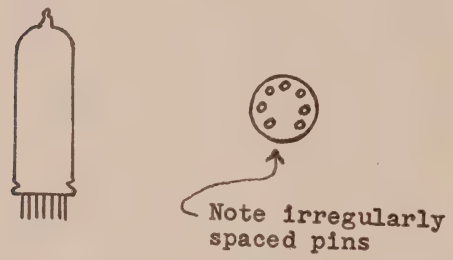


Figure 19. Miniature tube and socket

(2) NO PICTURE, SCREEN DARK, SOUND NORMAL

A fairly common complaint in television receivers is that of failure of picture and brightness altogether, but with sound remaining normal. In other words, if you still receive sound as usual, but the screen is completely dark, even with the BRIGHTNESS and CONTRAST (or PICTURE) controls turned full on, there is a good possibility the only trouble is a burned-out tube.

First remove the rear cover from the cabinet. Early in the chapter titled TELEVISION ADJUSTMENTS, there is a section headed, REMOVING THE REAR COVER OF THE CABINET.

Somewhere on the chassis there probably is a perforated cover or cage over two or three tubes. All tubes in this cage are likely suspects in the complete failure of picture and brightness. Examine this cage carefully for a way to remove the top, and/or one or more sides. Usually there are from two to six or more screws, which when removed allow the top and/or one or more of the sides to lift off. Some of these covers are hinged. Many manufacturers have installed the safety interlock plug arrangement on this cover rather than on the rear cover to the cabinet. If such is the case on your set, observe the manner in which the small plug and socket fit together, so you can easily close the cover again firmly, with the plug and socket interlock making good contact. The way to do this is to carefully fit the plug-socket combination together, then press firmly, before putting any screws back into the cover of the cage.

Special Precaution: If your set has one of these cages, it is inside the cage that the very high voltage for the picture tube is generated. Modern television receivers are so constructed that even if one gets hold of this voltage there is not enough current to cause injury. It can, however, cause a small burn, and in any case it is unwise to take chances with it, hence these additional words of precaution: BE SURE THE RECEIVER'S ELECTRIC PLUG IS PULLED OUT BEFORE REMOVING THE COVER OF THE CAGE. In addition, since a temporary charge can remain even after the electric cord is pulled out, you can take the following step if you wish. If, inside the cage, there are any tubes with a connection cap on top, you can relieve the circuit of the temporary charge before touching this connection cap. Do this as follows: Touch one end of a piece of wire to the metal chassis of the set and while holding it there, touch the other end to the metal connection caps on the tops of all tubes in this compartment. There may be a small spark as the tube caps are touched; this is entirely normal. BE SURE THE PLUG IS OUT WHEN DOING THIS.

Before looking for bad tubes, look for a possible blown out fuse, one that looks like an automobile light fuse. Usually it is inside this perforated cage. Look closely to see if the fine wire inside fuse is broken. If so, replace with exactly the same type and size fuse. There should be numbers on it telling type and size.

Looking inside this cage (if your set has one) and on the rest of the chassis as well, locate all the tubes you can from the following list:

6BG6 6C4 6V6 7AF7 6Y6 1V2
3B24 8O16 7F7 6K6 12AU7 1X2
1B3 6AQ5 6SN7 7N7 2X2-A
6AU5GT 6BQ6GT 6CD6G
6AK6 6AU5 6BD5 6AR5 6SL7 12BH7 6W4
6AL5 6L6 5V4-G

If you see any tube that flashes or glows with a bright purplish light, replace it. However, a small bluish glow is usually all right.

If there is a chart showing tube locations, pasted either on the inside or any other part of the cabinet, or perhaps in an instruction booklet if you received one with the set, it would assist you in locating the tubes.

After you have located any tubes in this list which your set may have in it, replace whichever cover has the interlock plug-socket combination, so that the set can be turned on. Replace the electric plug and turn the set on. Allow several minutes for the tubes to become thoroughly warm.

DO NOT PUT YOUR HAND INSIDE THE CABINET WHILE THE SET IS ON.

After the tubes have had time to heat, turn the set off, remove the electric plug. If there are tubes with connection caps on top, take the precautionary step described above.

Now feel all tubes with your fingers, especially the listed tubes located previously. If one feels decidedly cooler than the others, it may be burned out. Take it and have it tested.

Note: It is often difficult to tell for certain about a 1B3/8O16 by this method. It may feel cool and still be a good tube. If in doubt about this tube, or if you cannot locate any other dead or cold tubes, you might wish to remove the 1B3/8O16 and have it tested in a radio-television store.

(3) NO PICTURE, NO SOUND, SCREEN DARK

A complete failure of sound and picture, with the screen dark and no sign of life in the set at all, can be due to tube failure quite easily. Use the same method described above, allowing the set time to warm up, then removing the back cover and feeling the tubes. Three of the possible tubes which might cause complete failure are:

5U4	6W4-GT	5Y3	
5V4	5R4GY	6AX5	6X5

There are of course, other tubes which can cause this trouble, but these are three common ones.

(4) THREE OTHER POSSIBLE TUBE TROUBLES

Three other possible troubles which can be attributed to tube failure, and tested for in the same manner described above are:

1. FAILURE OF SOUND, but with picture remaining normal.
2. FAILURE OF PICTURE only, but with normal brightness on the screen and sound remaining normal.
3. FAILURE OF PICTURE AND SOUND, with brightness still on the screen as usual. This difficulty can be due to the failure of the oscillator tube, usually a miniature tube.

(5) A.C.-D.C. TYPE TELEVISION RECEIVERS

Especially in the 7" size sets, there are a number of TV receivers whose tubes are wired exactly as in the small A.C.-D.C. radio sets. In the radios, if one tube burns out, they all go dead. The same is almost true with A.C.-D.C. TV sets, but here, because of the greater number of tubes involved, they are wired in more or less blocks or groups, so that if one tube burns out, not all the others will necessarily become dead and cold, but probably several will.

Not all these receivers will operate equally well on either A.C. or D.C., as will the radios of this kind, but some will. You can determine from your dealer whether your set will work on D.C. They are, however, wired up in the A.C.-D.C. manner for economy of manufacture reasons; by wiring the tubes in this fashion, the need for a power transformer in the receiver is either eliminated entirely or so lessened as to allow a much smaller transformer to be used.

Therefore if there is any kind of complete failure in your receiver—sound only, picture only, both sound and picture—follow the procedures outlined previously, but if you find more than one, possibly as high as five or more tubes cold and dead, it is likely that your receiver is one of this type. You will need to take all the cold tubes to have them tested. Refer to the Chapter IV, Section (1), COMPLETE FAILURE IN A.C.-D.C. RADIOS, for suggestions on removing and replacing several tubes at one time

(6) MISCELLANEOUS FAILURES AND TROUBLES

Complete failure may be due to one of the following:

1. Electric plug accidentally removed, or may be fitting receptacle improperly. 2. The safety interlock may not be secured firmly—see Chapter 1, Section (1). 3. Not all sets have them, but if you can locate a fuse somewhere in the set, it may be blown. If the tiny wire inside fuse looks broken, secure an exact duplicate fuse. If the new one blows also, there may be a short inside the set.

Hum in the sound may be due to the fine tuning adjustment being off, or perhaps the antenna may need adjusting. The latter is not too common.

Dirt on the face of the picture tube or on the rear surface of the glass front may cloud the picture, and should be removed occasionally, if you can easily get to it. Clean as you would a good mirror.

If the picture has shrunk, both vertically and horizontally, you may have a weak rectifier tube. Look in the set for tubes listed in Section (3) and have it or them tested.

One or more thin black or white vertical lines can sometimes be removed by adjusting the HORIZONTAL DRIVE control until they just disappear. Return control to original setting if no improvement is noted.

CHAPTER III

TELEVISION ANTENNA CONSIDERATIONS

(1) ANTENNA GENERALITIES

During the past fifteen years or so, we have become accustomed to the ease and simplicity with which regular radio broadcast programs could be received. Built-in antennas became so efficient as to make external antennas completely unnecessary in all home receiver installations. On older sets which required an external antenna, excellent results were often had from connecting to the bed springs, or perhaps tossing a piece of wire out the window.

Not so, with television! TV receivers are being manufactured with built-in antennas, but generally speaking their practical use is restricted to locations fairly close to TV broadcasting stations, or apartments where it is impossible to have an outside antenna. Unless you are well located with respect to TV stations, it is almost a certainty that an outside antenna will give you better pictures than a built-in antenna. The strength of the signal to be received in any particular location is an unpredictable thing. Contributing factors are the elevation of the station's antenna, the height of the receiver's antenna, the lay of the land, whether hilly, flat, etc., and the nature of the buildings in between the TV station and the receiver location.

The best possible picture reception with the very simplest antenna arrangement is had under the condition known as line-of-sight transmission. This occurs when there is nothing which would obstruct the view between transmitting and receiving antennas. Obviously, this condition exists only in a very few instances. Many televiewers are enjoying good picture reception far beyond this line-of-sight limit, by virtue of good receiver design and proper antenna installation.

The only sure proof as to whether or not a built-in antenna is practicable in any given location is to try a set which has one.

Where a built-in antenna proves insufficient for good pictures, one still has two choices, whether the antenna is to be placed outside, as on the roof, or mounted on brackets on the side of the house. In any given location, an outside antenna probably will operate better than one inside the attic, especially if the outdoor antenna can be placed at a height above the roof level. However, some TV set owners are satisfied with an attic antenna installation, either because the landlord will not allow outside installations, or because of the freedom from further trouble once it is installed. An outside antenna, being subject to the elements, can develop troubles necessitating occasional repairs or maintenance. Wind vibration can cause mounting brackets and lead-in connections to work loose. By no means, though, is this meant to discourage you from putting up an outside antenna if one is needed, and it is permissible to install one. Indeed, receiving a good TV picture is worth a great deal of trouble; the suggestions concerning the attic installation are meant to point out true conditions, and show that there are things in favor of putting the antenna in the attic.

If the antenna is put in the attic, the lead-in can be brought through closets to the floor on which the receiver is to be used, if such is convenient, or it might be run out through an attic ventilator opening, or through a hole bored for that purpose, and thence down the side of the house just as it would be if the whole installation were outside.

The installation and up-keep of a television antenna are a great deal more critical than when dealing with a standard broadcast radio set. If you will familiarize yourself with a few fundamental requirements, you will be able to see whether your antenna and lead-in are properly installed, possibly even improve on the installation, and certainly to maintain it for continued good reception.

In television, the wire running from the antenna to the receiver itself is not correctly referred to as a "lead-in," but rather is called a transmission line. However, since the term lead-in is so installed in people's minds, this more old-fashioned term will be used in this writing.

There are two kinds of lead-in used in home installations. One is made up of two wires parallel to each other and held in position about ⅜" apart by a plastic-like insulation material which is flexible but rather tough. Technically this type is called 300-ohm lead-in; commonly it is called ribbon type lead-in.

The second type of lead-in is called co-ax, which is the abbreviation for co-axial transmission line. It also has two conductors, of course, one being a wire in the very center, surrounded by a layer of high grade insulating material. Wrapped around this layer of insulating material is a metallic braid which acts as the other conductor. The braid is in turn covered by a weatherproof outer insulating coating.

How should you know which kind of lead-in your installation needs? This is determined by the design of the TV receiver. All TV receivers are designed for one type or the other. Of late, the preference seems to run to the ribbon type. Somewhere on the set, either near the antenna connection screws or on a manufacturer's label which might be pasted anywhere on the cabinet, even inside, it may be stated whether that particular set requires a 300-ohm or a 72-ohm lead-in or transmission line.

300-ohm lead-in or transmission line is the ribbon type, about ⅜" wide.

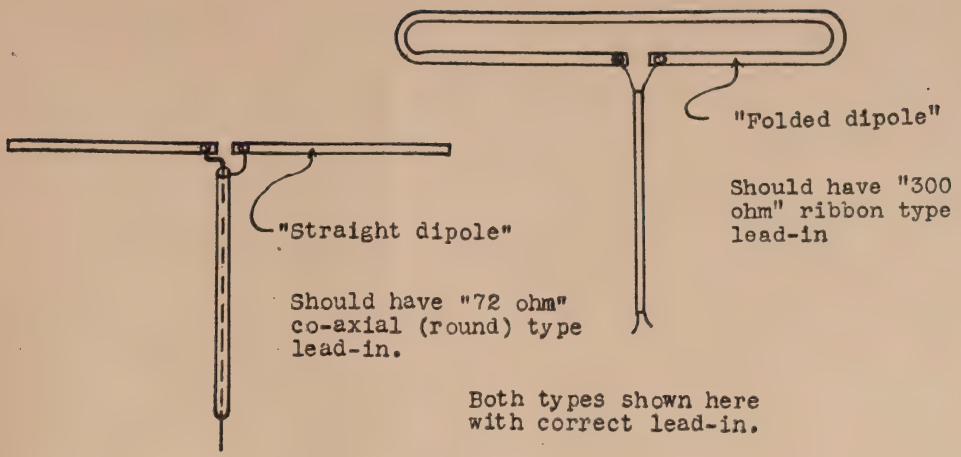

"Folded dipole"
Should have "300 ohm" ribbon type lead-in
"Straight dipole"
Should have "72 ohm" co-axial (round) type lead-in.
Both types shown here with correct lead-in.

Figure 20.

72-ohm lead-in is round, about the size of a lead pencil; it is called co-axial or simply co-ax.

If you cannot find it stated on the set, or in any literature you may have received with it, your dealer should be able to tell you which type of input your set has—72-ohm or 300-ohm.

Just as there are two types of lead-ins, there are two types of antennas; one kind which is meant to be used with the 300-ohm ribbon lead-in, and the other kind which is supposed to be used with the 72-ohm co-ax lead-in.

A fundamental sketch of the two types of installations is shown in figure 20. Actually, of course, there are many variations of both types, but you can always tell the antenna meant to be used with the 300-ohm ribbon lead-in and 300-ohm receiver input, by the way it appears to be folded back on itself. In fact, that is where it gets its name—FOLDED DIPOLE. Dipole is pronounced die-pole, with the accent on the first syllable—die. The ends of the antenna are poles. The prefix die means two. Since the two ends are folded back, it is called a folded dipole. The antenna with two ordinary ends is simply called a straight dipole.

In areas reasonably close to TV transmitting stations, where the strength of the signal is considerable, some liberties can be taken in installing ribbon lead-in where co-ax should be used, and a straight dipole antenna where a folded dipole belongs, and still receive an adequate picture. However, wherever there is a choice, and certainly when you are a considerable distance from stations, say, more than fifteen miles for example, it would be better to follow the proper specifications.

There have been a number of variations of the two fundamental antenna types. This does not alter the fact that all antennas used for TV receivers can be placed in one class or the other. Keep in mind that if the ends of the antenna are open and free, whether it is a single bar or rod, or whether it takes the form of a large letter X, or some other form, it is fundamentally a 72-ohm antenna, requiring for the best possible results a co-ax or round shaped lead-in.

If on the other hand, the ends of the antenna are folded back into a rod the length of the antenna and located about two to four inches above it, it is a 300-ohm antenna and needs, if the fullest results are desirable or necessary, a ribbon type lead-in.

A very few, rather wierd-looking antennas can be seen from time to time. If yours happens to be one of these, you would have to depend on the store from whom you obtained it for information as to whether it is a 72-ohm or a 300-ohm antenna. Remember:

72-ohm antenna ..... Co-axial (round) lead-in.
300-ohm antenna ..... Ribbon (flat) lead-in.

If the ribbon lead-in is used, it should be insulated from walls, etc., especially outside. It never should be laid flat against any metal surface. In the best installations, it is mounted on some sort of stand-off insulators, which keeps it from flapping in the breeze, and holds it at least an inch from building walls, etc. Some deviation must be tolerated occasionally, depending on individidual conditions. Inside, for instance, where the wall is always dry, it may be tacked down, but the tacks must be in the exact center of the ribbon and not pounded down tight enough to cut into the wire. Also, it should not lay flat against the wall, but be twisted about once in every foot and a half. In fact, it is good practise to twist the lead-in about once in every foot or two, all the way down from the antenna. This is to lessen the tendency of the lead-in to pick up interference, such as car motor noise, etc.

The co-ax lead-in can be fastened down to a

wall, either indoors or outside, without harm to the picture signal. It can be secured with staples, though they should not be pounded in hard enough to cut through the protective covering into the metallic braid. It is preferable, though, not to place the lead-in too close to metallic bodies of any appreciable size. For example it should not lie on a tin roof, and shouldn't be wrapped around a down spout.

In installations where there are more than one ribbon lead-in coming down from the antenna, they should be kept separated, preferably by more than one inch, and within reason, the further apart, the better. They definitely should be fastened down securely so as not to blow against each other in the wind. They should be twisted, as mentioned previously.

There are a number of facts, some technical, some common sense, the understanding and application of which will help you keep receiving as good a picture as your original installation permits. In fact, if you wish to make an extra effort, some phases of reception may even be improved in many cases. These statements have reference to the signal pick-up by the antenna. Many installation men are conscientious and spend the time and energy necessary to properly orient the antenna. Orient is defined—to turn to a specified direction. There are those, however, who for one reason or another, sometimes do not get that final touch on the antenna installation. As a result, you may be troubled with more snow than necessary on some stations, or perhaps ghost images on the screen.

If you are a TV set owner, chances are that you know what snow is—that annoying, flickering, speckled effect all over the picture which so much resembles snow falling that it has been given that very name. What is snow, and why do you get it more on some stations than on others? Snow is noise, seen on the picture screen. It corresponds to noise which you hear in the speaker of a conventional radio set. It is always present, and you receive it the most when you tune to a weak station. The stronger the signal received from the TV station, the more it can overpower or drown out the snow. Hence, to reduce the snow, it is necessary only to receive a stronger signal from the station. Hence, the better the antenna works, the less snow you'll see on your screen.

Special Note
Lightning Protection

It is doubtful if all outside antennas are provided with satisfactory protection against lightning. Of course, no provision assures absolute protection, but two things can be done, and you can easily check for yourself whether either or both has been included in your installation, and if not, you can either do them or see to having them done properly from the following.

First, practically all antennas are mounted on an upright pole or pipe which in turn is secured to the house or chimney by metal brackets of some kind. A heavy copper wire, preferably insulated, should be connected to the upright pipe and mounting brackets and run down a corner of the house to a metal pipe or rod driven two or three feet into the ground. The wire may be secured to the house by ordinary staples.

Second, special lightning arrestors have been designed for use with TV antenna installations. If you have more than one lead-in, each should have its separate lightning arrestor. It or they should be installed just outside the point where the lead-in enters the house. A lightning arrestor is, actually, just two pieces of carbon placed close together, but not actually touching. One piece connects to the lead-in, the other to a ground wire. When lightning strikes, it usually jumps across the small air gap and goes to the ground instead of sending its main force into the house via the lead-in. The wire connecting the lightning arrestor to ground should be a heavy one and preferably insulated. Number 8 or 10 electric light wire should be suitable.

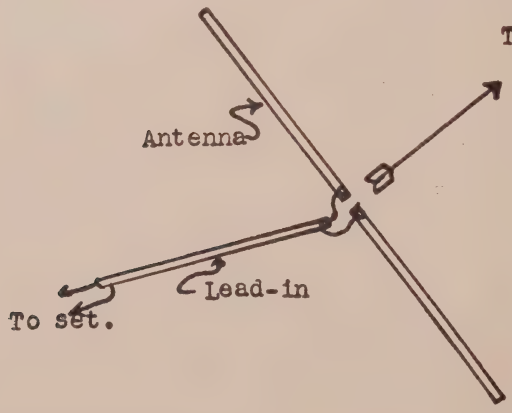


Figure 21.

(2) ORIENTING THE ANTENNA TO REDUCE SNOW

In general, it is correct to say that the antenna should face broadside toward the station you wish to receive. See figure 21.

However, when there are two or more stations in somewhat different directions, you need to compromise to some degree. Thus, if there is a station to the north of you and another to the west, your antenna can hardly be broadside to both. And, if it is broadside to either one, you will receive little or no signal from the other, and will get heavy snow on the second station. This is because when the end of an antenna points toward a station, a very minimum amount of signal is picked up from that station. Incidentally, this is the essential principle used in radio direction finding by airplanes and ships. To continue, an antenna in such a location as this, must be pointed in a general northwesterly direction. It is here that patience and a little extra effort may spell the difference between good and poor reception on one station or the other.

Planning strictly by the compass is not the solution, since one station may be farther away than the other, or may have less power, making the signal weaker from the one station. In such a case, the antenna direction will need to favor the weaker station, and you have no way of predetermining this. Only patience and trial and error will solve this problem.

If you believe you are in a situation comparable to the above, and are getting considerably too much snow on one station or more, and you, or some member of the family, or even a friend who "looks in from time to time," can "make like a monkey" enough to get up to the antenna and try a little experimentation, very possibly you may improve your reception considerably.

There is really only one satisfactory way to accomplish this end. That is, successively adjust the antenna to several different positions, and while the antenna is in each one of these positions, tune the set to the various channels you expect to receive. You no doubt will find antenna positions which will be good on one or more channels and very poor on others. With patience, eventually you should find the antenna direction which will give the best over-all performance on all channels.

The most convenient method used by professional installation men is to work in pairs, each man having a hand-set telephone with a temporary hook-up between the antenna location and the receiver location. One man works at the antenna, while the other tunes in the various stations; with continual conversation between them during the antenna rotating experiments, they can arrive at the best possible arrangement in the shortest possible time. You can do as well, though perhaps not as quickly, by having two persons help you. One, working at the antenna, one tuning the set, and the third, posted just outside a window, so that he can talk to both the other workers, and relay information back and forth between them. Each time the man at the antenna states to the go-between man that he has turned the antenna to a new direction, he in turn can tell the man at the receiver to try all the channels. As soon as this is done, the results can be relayed back to the antenna man who in turn tries a new antenna position. This keeps up until the man at the receiver is satisfied that the best arrangement has been reached.

As a last resort, one person can do the job himself by the simple if slightly laborious process of coming down to the set and tuning in the different channels each time he turns the antenna to a new position.

Most antennas are installed in somewhat the same manner—mounted on an upright pole or pipe which in turn is held in place by some sort of bracket and clamp arrangement on a side wall, or perhaps on a chimney. The bolts which hold the clamping bracket around the upright pole or pipe, when loosened slightly, should allow the whole assembly to be rotated, thus changing the direction the antenna faces.

Important: If the antenna is made up of two sections, of different lengths, one above the other, you should not turn the complete antenna assembly at once, when orienting it to improve reception from one station or another. The reason for this is that the shorter of the two sections is meant

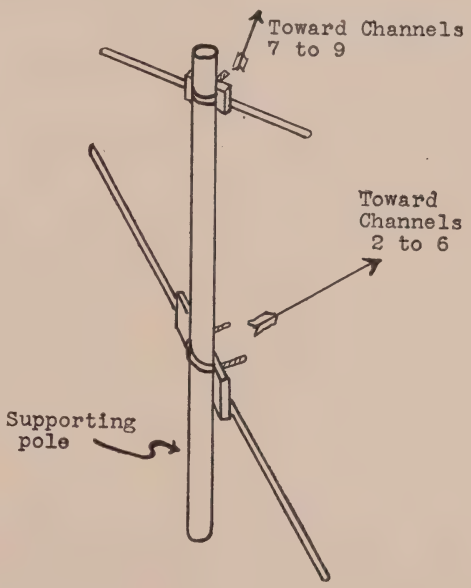


Figure 22.

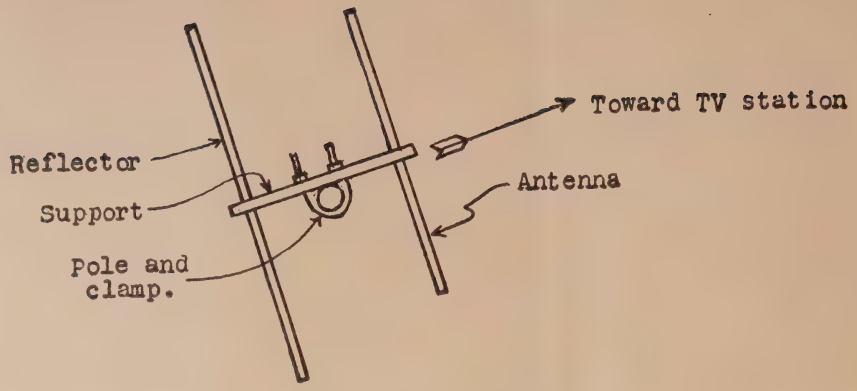


Figure 23. Downward view

to receive Channels 7 to 13 inclusive, while the longer section receives signals 2, 3, 4, 5, and 6. (There is no station on Channel No. 1; this channel has been closed by the Federal Communications Commission, the Government Agency which issues licenses to operate stations). See figure 22 for an illustration of this kind of antenna installation.

In this type of arrangement, there is doubtless some provision at the point where each of the sections is mounted on the pipe or pole to allow it to be loosened and turned without disturbing the remaining section. When attempting to improve reception from any of the channels between 2 and 6, (including 6), only the longer section should be rotated. If the station or stations you wish to receive better is/are between Channels 7 and 13, inclusive, only the shorter antenna element should be rotated.

If, however, your antenna has more than one section above and below each other, and the upper and lower sections are the same length, then the entire assembly must be rotated as a unit.

Important: When an antenna has two parts on the same level, with the lead-in connected to only one of these elements, the element without the lead-in connected to it is a reflector. As one would expect, the reflector must be to the back of the antenna proper with respect to the station or stations to be received. See figure 23.

The reflector is exactly what the name implies; it bears the same relation to the antenna proper that a reflector in a flash-light does to the bulb. It beams reception to a desired direction. The reflector on a TV antenna is always slightly longer than the antenna itself.

In more elaborate installations, the antenna may even consist of four antenna elements, each with a reflector. The upper two elements would be the same length as each other, and with their reflectors would be beamed in the general direction of stations on Channels 7 through 13. The two lower elements should likewise be equal in length to each other, and considerably longer than the two top elements. The lower assembly of two antenna elements, each with its own reflector should be oriented toward stations received on Channels 2 to 6 inclusive. This arrangement is shown in figure 24.

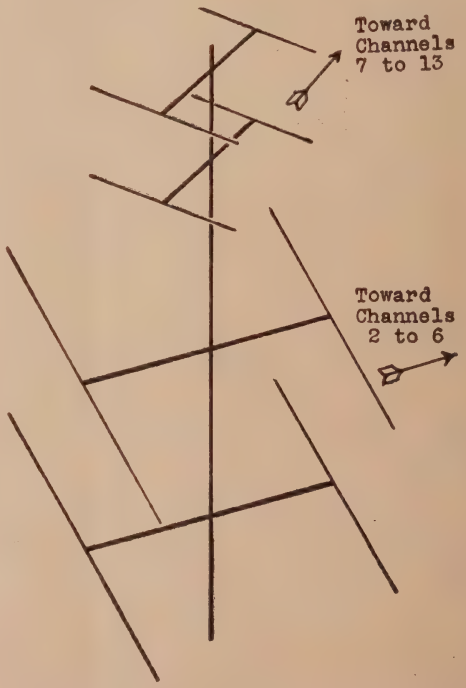


Figure 24.

(3) ORIENTING THE ANTENNA TO REDUCE GHOSTS

The other consideration in adjusting the antenna direction is the reception of ghosts. First, what is a ghost? You are receiving a ghost, if the picture on your TV screen looks like a photograph would look if you first snapped one picture with a camera, then turned the camera slightly to one side and again snapped the same scene on the same film.

A ghost is caused by receiving in addition to the regular signal directly from the station, another signal which is "bouncing off" some tall building, hill, or other physically prominent landmark. Since the direct path from the transmitting station to your receiving antenna is shorter than the path followed by the reflected signal, the direct signal arrives an instant previous to the arrival of the reflected signal. Since the reflected signal arrives an instant later, it appears as a separate picture. You may be interested in knowing that the distance between the two images on your screen is a direct indication of the extra distance followed by the reflected signal. The shortest distance between two points is a straight line. The straight line in this case being the direct path between the transmitting station's antenna and your receiving antenna. Although we are accustomed to think of radio and television waves travelling through the air virtually instantaneously, actually it requires a measurable amount of time. The further apart the two images appear on your TV screen, the greater "out of line" is the building or other object causing the reflected signal. In a small measure, this illustrates the principle upon which radar operates.

Although radar applies this idea to a useful purpose, in a TV receiver the reflected signal is undesired and you are concerned only in getting rid of it. There are cases where it cannot be eliminated entirely, but in any installation where a ghost is received, it certainly can be minimized by carefully adjusting the direction faced by the antenna. The suggested procedure in cutting down the amount of snow in the received picture applies exactly to the minimizing of ghosts, that is, experimentally changing the direction the antenna faces, while observing the picture on the screen for each new position, until the best all-around results are obtained.

In adjusting the antenna to solve the ghost problem, you need to keep checking on the other channels to see that not too great a loss in picture quality is suffered on them while attempting to eliminate the ghost on any certain station.

As you may have guessed by now, adjusting a television set includes many compromises, since some factors depend on each other. When making an adjustment to improve one action causes a deterioration in some other picture quality, you have to decide how much loss on the one hand you are willing to tolerate in order to make the desired gains. No amount of study or planning, beyond certain fundamentals will solve this problem; it must be decided in each individual case according to one's own preference.

Remember here also, that in dealing with an antenna which is built up of two sections, one above the other, with one section much longer than the other, the shorter section only should be rotated when working with Channels 7 through 13. Only the longer section should be oriented when attempting to improve reception on Channels 2 to 6 inclusive. On the other hand, if the upper and lower sections are the same length as each other, the complete antenna assembly is to be rotated.

(4) IF YOU LIVE A GREAT DISTANCE FROM TV TRANSMITTING STATIONS

If you live in a more or less rural area, at least as far as television broadcasting stations are concerned, your antenna problem is of prime importance. For example, a TV set owner living in northwestern Missouri, should be able to receive satisfactory TV signals from Kansas City, Mo., if his antenna is of good design, properly installed, and oriented. In such cases, height of the antenna is extremely important; within reason, the higher the better. Here again a compromise creeps in. The antenna cannot be raised higher and higher at the expense of making the lead-in too long. Exceptionally long lead-ins cause a loss in picture quality. There is no hard and fast rule regarding the length of lead-ins versus antenna height, but one or two rules can be observed. Place the antenna as nearly straight above the receiving set as possible; try not to put the antenna on one end of the house and have to run the lead-in the length of the building to reach the set at the other end. In all cases, make every effort to run the lead-in directly to the set; do not run it under the eaves or down the corner of the house, simply because it looks neater, if there is a shorter direct path down the side.

To continue the problem of the northwestern Missourian, there also are stations in Omaha, Nebraska, and eventually there should be in Des Moines, Iowa. Unless televiewers wish to restrict themselves to receiving stations in only one of these three cities, their antennas will need to be a bit on the elaborate side. There are two ways of approaching this problem. One is to erect separate antennas, one beamed toward each city, and each antenna having its own lead-in. The lead-ins are all brought to a central point at the location of the receiving set, and connected to a multiple point switch. This switch is in turn connected to the TV set, and when the viewer wishes to tune in a station in any given city, he simply switches to the antenna beamed toward that city.

Another method is to mount the complete antenna assembly on one of the commercially built antenna rotating motors made expressly for this purpose. An electric wire is then run down to the location of the TV receiving set, and

connected to a control box, furnished with the antenna rotating motor. Then when tuning in any station, the viewer only has to turn his antenna by means of the remote control box until the picture comes in the best. In typical American tradition, mechanically inclined individuals no doubt will come up with mechanical schemes to accomplish the same purpose without the use of a motor. Amateur radio operators have been doing the same thing for years. Many of them have their highly directional beam antennas mounted on some sort of rotating device operated by pulleys, ropes, etc.

(5) ANTENNA LEAD-IN CONNECTIONS MUST BE CLEAN AND TIGHT

It is essential that all connections from antenna to set be thoroughly clean and tight. If they are not, you may be troubled with either consistently or intermittently poor reception in the form of weak pictures and sound, excessive snow on all channels, and perhaps popping or scratchy noises in the loud speaker. The picture may be good one instant and poor, or completely gone, the next. This condition can be especially aggravating when the wind is blowing.

If you are troubled with any of the symptoms in the above paragraph, it is a good plan to examine all connections carefully, beginning with the junction of the lead-in and the set, since this point is handiest. If they are screw connections, see that the wire fits securely under the screw heads, and that the screws are tight. If the wire does not fit well under the screw heads, loosen the screws, remove the wire ends and if the strands are awry or frayed, twist the loose ends between your thumb and finger, like twisting the end of a string or thread preparatory to threading a needle. Then wrap the wire ends tightly around the screws under the screw heads, and tighten the screws firmly. Be sure to get the wires back under the two screws from which they were removed. Make certain that a loose end of one wire does not touch the other wire or connection screw. If the connection of the lead-in to the set is not made with screws, but rather to a length of lead-in wire protruding from the inside of the set, make sure that the splice between the two is tight and clean. Here also, see that no loose wire ends make contact with each other.

In a good installation, there should be no splices between the set and the antenna, but if for some reason there are any, check to see that they are secure and clean, and there are no loose ends. Splices, if any, should be taped with rubber tape rather than ordinary friction tape.

The greatest danger from loose and dirty connections, however, is at the junction of the lead-in and antenna. If it is not too difficult to reach the antenna, you can help insure continued good reception by an inspection of same, possibly each autumn and spring. Or if you are troubled with any of the above mentioned symptoms, but still get steady brightness on the screen, there is at least a fair chance of trouble at the antenna.

It is good practise to loosen the screws where the lead-in is connected to the antenna and remove the wire ends for cleaning and inspection. If several of the strands are broken due to the wind blowing the lead-in back and forth, the insulation should be skinned back about an inch and a fresh end used for connection. If the wire seems good, but is dirty, scrape it thoroughly with a pocket knife, and after twisting the strands together like a man twisting the point of a long moustache, wrap the wire ends under the screw heads and tighten screws securely. It is possible that instead of the loose ends being directly under the screw heads, the wires may be soldered to the ends of what are called soldering lugs, and these lugs in turn are under the screw heads. If the wire is not broken, clean the surface of the lugs where they come in contact with the antenna or screw heads or nuts, replace them as they were and tighten the screws or nuts securely.

Do these same things for any connecting links of wire going from one antenna element to another.

Make a general inspection of all parts of the antenna installation, to see that all screws, mounting brackets, etc., are secure and have not worked loose due to wind vibration. You may easily prevent the antenna from falling down entirely by one of these inspections. Unfortunately, many antennae get installed in a hurried manner, due to last-minute rushes for one reason or another, and if yours happened to be one of these, you can save yourself some possible grief by an examination from time to time. If a mounting bracket is put up with wood screws, and one or more screws have worked loose, replace them with a size larger screw and you will be doing yourself a great favor.

(6) SOOT DEPOSIT ON ANTENNA

If gradually over a period of time you have observed more and more snow on all channels, take a look at the antenna from another standpoint. In especially smoky locations, such as in the case of an antenna mounted on the chimney, for example, or in any location for that matter, if the antenna has been up for a long time (outdoors, that is), it may have become coated with a layer of carbon from soot having settled on it. This deposit should be cleaned off the antenna with sandpaper or steel wool. It is wise to pay particular attention to that portion of the antenna which has the lead-in connected to it. Preferably, remove the screws and nuts holding the lead-in on, and clean thoroughly all sooted surfaces. The lead-in itself should also be cleaned of this deposit. A dry cloth may do for the lead-in, but soap and water may be required if the deposit is heavy.

CHAPTER IV

RADIO TROUBLES

(1) COMPLETE FAILURE IN A.C.-D.C. RADIOS

This chapter deals with one of the commonest of complaints in those popular little A.C.-D.C. models. Some families have several scattered through the house, supplementing the larger floor model in the living room. Often, especially in apartments, the A.C.-D.C. set is the only radio in the home. As you may know, they are so named because they will operate equally well on either A.C. (Alternating Current) or D.C. (Direct Current). You probably know whether you have a set of this type or not. If you do not know, look on the underneath side of the cabinet, or on the back of the set, or perhaps inside the cabinet for a manufacturer's label which should give this as well as other information about the set. If you cannot locate the label, your dealer or any dealer selling the make you are using should be able to inform you if the model in question is an A.C.-D.C. set or not.

When you turn the set on and after a reasonable warm-up period you hear no sound whatever in the speaker, that is, no hum, no clicks, no static-like noises, even though you turn the VOLUME control on full and move the tuning dial back and forth, one of the following steps may locate the trouble:

1. Be sure the plug is firmly in the electric outlet. It may have been accidentally removed or partially pulled out while doing household chores or for some other reason. Though this step may seem trivial or obvious to you, rest assured that it is the very first step taken by an experienced serviceman. He never takes anything for granted, and if you will follow this example, it may surprise you how often you may locate trouble which might be overlooked by the average novice in his haste to make a big job out of a little one. Do not feel self-conscious at finding a plug pulled out; skilled engineers have been observed wondering why a given piece of equipment would not work, then to suddenly remark, "Well, well, it works better with the plug in." Such will not always be true, of course; radios and television sets do develop major troubles, and when they do, you will want a thoroughly experienced serviceman to repair them. It should be emphasized, though, that often the same symptom may point to a minor difficulty and a simple solution, and be mistaken for a more serious breakdown. If you play it safe, and step by step, eliminate the simple, innocent-appearing possibilities, it may pay you many dividends in money, time and effort.

2. Although one of the sales points for the A.C.-D.C. sets is the fact that they will work equally well on alternating current or direct current, the fact is that very few localities are served with direct current. Almost all homes have alternating current, and in these locations, it makes no difference how the electric plug is inserted into the receptacle. If, however, you happen to be in one of the few areas which has direct current in the house wiring, the set will not work at all if the plug is reversed from its correct position. Determine from your landlord or power company if you are in doubt whether or not you have direct current, and if so, try pulling the radio plug out, turning it half-way around and reinserting it. Whether or not this operation causes the set to begin playing in this particular instance, keep the thought ever in mind that the plug must be in the socket one particular way, if you use direct current in your electric wiring. Always try reversing the plug when the set does not operate.

3. The electric outlet itself may be faulty. A simple quick check as to whether or not it is normal is to remove the radio plug, and plug in a lamp which you know is in working condition. If the lamp lights when it is plugged in and turned on, the outlet as a suspect can be written off as not guilty, and you may proceed to the next step. However, if the lamp plug seats firmly in the outlet, but will not light when turned on, it is possible that the outlet is not supplying current. Before assuming it is definitely defective, however, consider the fuses. In some houses and apartments, all the outlets are not on the same fuse circuit, so it is advisable to examine all fuses. You probably know where all your house fuses are located, but if you do not know, make a thorough search in such places as basement, halls, kitchen, porches, etc. Apartment houses especially, and perhaps some houses may have two or three fuses in such locations as these, in addition to the main fuses at the meter. Wall outlets are often fused separately from ceiling lights, so don't feel that because the lights work, the outlets cannot have a burned-out fuse; examine all fuses. If you live in an apartment, consult your landlord or building superintendent when in doubt about fuses.

You cannot always tell for certain whether a fuse is burned out by looking at it; when in doubt, try a new one. Make certain that all fuses are screwed in tight.

Just because one fuse has blown does not mean for sure that there is a short somewhere. Although seldom, sometimes fuses burn out for no apparent reason. Also they can blow due to turning on too many appliances at once.

As a double check on the outlet, you may wish to try other lamps or appliances in the question-

able outlet. If none work, and you are sure all fuses are good, it is a virtual certainty that the outlet is defective. Since working with house wiring circuits is hazardous, unless you are in the habit of taking care of such work yourself, I suggest you have your regular electrician examine it for possible repair or replacement. If renting, report it to your landlord.

4. If the outlet was found to be satisfactory, or the radio does not play when plugged into a receptacle which definitely does supply current normally to other appliances, there is an excellent chance that a tube is burned out.

Turn the receiver around so the rear of the set is facing you. On some few models, you will have immediate access to the tube line-up. If you do, you may skip the next paragraph.

If your set has a rear cover, it probably is fastened at the corners and perhaps the edges with screws or some sort of fasteners which snap in and can be pried out with a knife edge. Remove these screws or fasteners so as to free the rear cover. However, do not immediately pull it clear aside, but rather, pull it slowly and gently aside while observing whether or not it has wires secured to it. The reason for this is that often the built-in antenna is mounted on this back cover. Usually the wires are long enough to pull the cover aside sufficiently to gain access to the tubes. On some models the wires will be terminated in a removable connector of some kind which can be removed from a connector terminal on the antenna and cover. If this is the case, as you remove the wires, make certain there is provision for getting the wires back on the same terminals from which they are removed. If there isn't some kind of color code and marking for this purpose, make your own marking by tying matching colored threads on each wire and the terminal from which it is removed. In fact, you can remove any number of wires from terminals by this process, and be able to correctly replace them. Just before removing any given wire, tie a certain color thread around it, red, for example; then, when you loosen that wire, tie a red thread around the terminal. For the next wire use, say, a blue thread, and a blue thread around its terminal, and so on.

If the cover has no wires fastened to it, lay it aside, but the loop antenna may still be between you and the tubes. In such cases, it can be removed or at least pulled aside, by loosening one or more screws; you should have no difficulty in seeing the screws. If the screws do not have slots for a screw driver, you can use a pair of pliers if you have no spin-tight wrench. A spin-tight wrench is one which looks like a screw driver, except that the end is in the form of a socket which fits over hexagon shaped screw heads. Often there is only one screw in the very center of the antenna.

Important: At this point, make certain that all tubes are pushed firmly down in their sockets. Occasionally one may have worked loose and still be in place, but not down far enough in the socket to make good contact, the result to the set being the same as if a tube were burned out. And this result is to make all tubes inoperative in a A.C.-D.C. set.

5. If all tubes are down firmly in place, be sure the plug is in the receptacle, and turn the set on. Allow a minute or two for the tubes to warm up. Now feel all the tubes with your fingers to determine if there is any warmth in them. If after a few minutes the tubes are still cold, one of them is almost surely burned out.

The reason one inoperative tube, either burned out or not down in the socket securely, can render the entire tube line-up useless and cold is that tubes in A.C.-D.C. sets are wired in series, the same as strands of Christmas tree lights in which one burned-out bulb (or one slightly unscrewed in its socket) will cause the whole strand to go dark.

There is a chance that more than one tube may be burned out, but in most cases, it will be only one.

You will wish to remove all the tubes and take them to a store which sells tubes and have them tested. If you have never removed all the tubes at one time before, you will want to read all the following instructions before proceeding.

SWITCH THE SET "OFF" AND PULL THE PLUG OUT.

In older sets, some tubes may have a small cap on the top, with a wire connection from it to some part of the set. This connection should slip right off; just take hold of it and as you pull straight up, turn it slightly to loosen it. It is unlikely that this wire is long enough to reach any but the tube from which it was removed, but to be on the safe side, look to see if it could possibly be put on any other tube. If it could be, then write the number of the tube from which you took this particular wire, on a small slip of paper, and tearing a small hole in the paper, slip it over the wire or fasten it to the wire with scotch tape. This will insure getting the wire connection back on the correct tube. The matter of tube numbers is discussed further on.

Before removing any tubes, look on the bottom of the cabinet, on all parts of the inside of the cabinet (side walls and top), and on both sides of the rear cover, if any, and see if there is a manufacturer's label which may have on it a pictorial diagram showing the various tube numbers and socket locations. This label, if found, will solve the problem of locating the various tube sockets when ready to replace tubes. Also if you are unfamiliar with the numbers on tubes by which they are identified, this chart will be a guide to the numbers for which you should look.

If the manufacturer's label cannot be found,

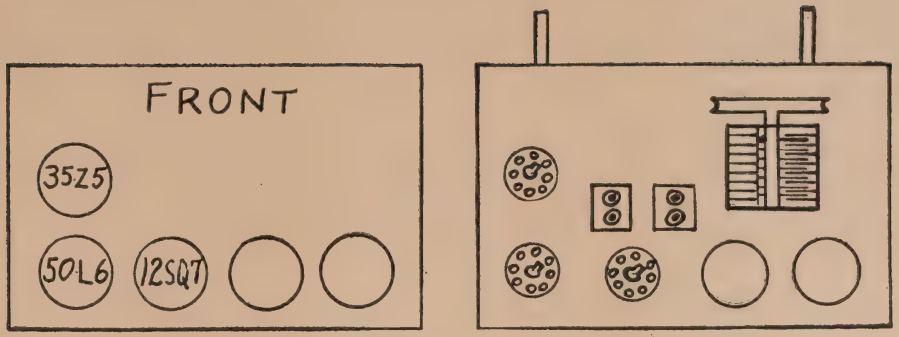


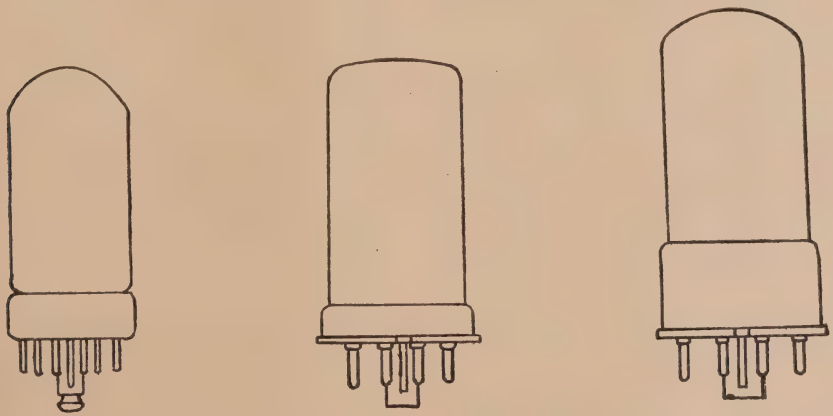
Figure 25.

there are two ways in which you can insure being able to return all tubes to their proper sockets. Either method would be facilitated somewhat if the chassis were removed from the cabinet, although this is not absolutely necessary.

One method is to make your own pictorial diagram of the positions of the tubes. To do this, place a sheet of paper alongside the set and indicate which edge of the paper is to represent the front of the set, and then proceed to sketch a circle in the approximate location of each tube. Then as you remove the tubes, write inside each circle the number of the tube which belongs in that particular socket. When you are ready to replace the tubes in the set, it is a simple matter to again place the paper on the table beside the set, with the margin marked as representing the front of the set in the proper respective position, and put in the tubes according to the notations. Figure 25 shows a receiver chassis and sheet of paper as they would be when part of the tubes have been removed.

The other method is, as you remove each tube, write in pencil directly on the set chassis next to the socket, the number of that particular tube. If the chassis is chromium or some finish on which a pencil will not write (although this is seldom true), stick a small bit of adhesive tape on the chassis near each socket and write the tube numbers on them.

When removing a tube, grasp it firmly, by the base if you can reach it, and while rocking it round and round in a small circle, pull straight up. You will find some tubes fit quite tightly, others will come out easily. In very stubborn cases, if you can reach the tube base, slip the flat point of a screw driver a little way under the base and pry up while continuing the circular rocking motion with the other hand. Caution: Make doubly sure the set is turned *off* when



"Lock-in" type

Metal tube

One style of glass tube

Figure 26.

doing this; also do not use the screw driver on miniature tubes, since they have no metallic or bakelite base; they are glass clear to the bottom. Miniature tubes are about the size of a man's finger.

A particular type of tube which should receive special note is the lock-in tube. It was built especially to stay put in its socket under rugged conditions of handling. Consequently, when it comes to removing one of these from its socket, it appears a bit stubborn. Figure 26 shows this tube in a side view, along with certain other types, so you can easily tell when you have come across one of them. You can identify the lock-in type of tube by the fact that the base looks more like a narrow metal band around the lower portion of the tube.

To remove a lock-in tube from its socket, grasp it firmly, and pull upward rather strongly, while rocking the tube around in a fairly wide circle; not wide enough to risk bending the prongs or breaking the tube, however. Just remember that they require a stronger pull and an extra emphasis on the circular rocking motion as compared to other tubes.

Occasionally the glass portion of a tube will appear loose in the base. That is, you can grasp the glass and twist it back and forth slightly while not moving the base. This is caused by the cement which holds the glass in the base coming loose, and does not necessarily mean that the tube is useless. Obviously, you cannot pull it out of its socket by pulling up on the glass, as that would definitely finish its life, but you can pry it out of the socket, or pull it out by getting hold of the base as mentioned previously. A tube in this condition may last a long time, but it is well to wrap a strip of scotch or adhesive tape around the portion where the glass meets the base, overlapping both glass and base, to lend strength.

Immediately upon removing a tube from its socket, examine it for its identifying number. If you are totally unfamiliar with the markings on tubes, at first glance there may be some doubt in your mind as to just what is the number by which a given tube may be identified. To give you an idea what to look for, here is a list of tubes which you might find in any A.C.-D.C. set:

43	12K7	14H7	50B5
75	12SA7	25L6-G	50C5
6A7	12SA7-GT	25Z5	50L6-GT
6D6	12SK7	35B5	5591
6Q7	12SQ7	35W4	9001
12J5	14C7	35Z5-GT	9002

There are, of course, many others not in this limited list.

The letter G following a tube number simply indicates that this is a glass tube. The letters GT at the end of a tube number signify a smaller size glass tube. Your natural assumption would be that all tubes without G or GT on them would be metal tubes, but to make things slightly confusing, this is not true. The only thing you can be certain of is that when the G or GT does appear, it is definitely a glass tube; if G or GT is not in the number, the tube could be metal or glass.

The above remarks are directed to those who for the first time are looking at tubes and wish to identify them. If there is any doubt about one or more tubes, it need not prevent you from removing them for testing. Simply stick a small bit of adhesive tape on the tube base and write on it some identifying symbol of your own choosing. You might write the letter A, for example, on the first tube removed, and write the letter A on the chassis near the socket from which it was taken. Then you could write the letter B on the adhesive on the second tube removed, and the letter B near the socket from which you removed it, and so on. Instead of adhesive tape, you might write the symbol on a small square of paper (about ¼" x ½" in size), and stick it on the tube by laying over it a piece of scotch tape slightly longer and wider than the paper. Be sure no one removes your marking in handling the tube.

Important Note: If one of the tubes is a 35Z5, you should also remove the dial lamp and take it along when having the tubes tested. The reason for this is that the dial lamp and the 35Z5 tube are always wired into a set in such a manner that either one burning out can possibly cause the other to burn out. Indeed, if your set has a 35Z5 tube in it, it is wise to always have a spare dial lamp on hand. If the dial lamp ever goes out, replacing it immediately may save the life of the 35Z5. If you look into the rear of the receiver you probably can see the back side of the socket which holds the dial lamp. This small socket is usually on some sort of bracket, removable by sliding off to the rear, to allow you to take the lamp out of the socket.

When taking tubes to a store for testing, it is wise to wrap each tube individually in a piece of paper (paper napkins are excellent for this) and carefully place them in a paper bag or small box so that they do not rattle around.

In buying tubes for replacement purposes, always try to get a metal tube if the old one is metal, and a glass tube to replace one that is glass. The basis for this statement is that many tubes come in both metal and glass, and in most cases glass and metal tubes bearing the same identifying number are interchangeable. However, if the manufacturer chose to put a metal or glass tube specifically in a given socket, it is good for you to follow this lead, if possible. Further, occasionally a glass tube may be had in two sizes, one with the suffix -G and a smaller tube with the suffix -GT. An example will clarify this situation and guide you in making tube purchases. The 6K8 is a metal tube. The 6K8-G is its glass counterpart, and though one may work where the other is now operating, if

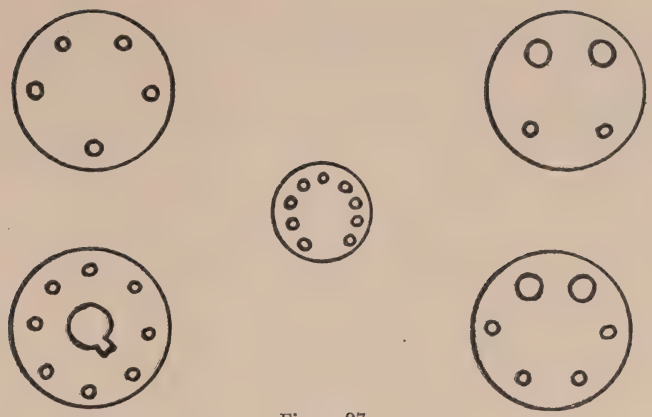


Figure 27.

you can get the same kind as the receiver now has, it is better practise to do so. The 6K8-GT is the same tube in a slightly smaller and different shape glass envelope. (The glass bulb of a tube is called the envelope by technicians.) Tubes whose numbers are identical except for the ending -G or -GT are interchangeable, in fact, some series of tubes are no longer obtainable with the suffix -G, only the tubes ending in -GT now being on sale.

When buying tubes, get a sales slip and keep it at least ninety days. Tubes usually are guaranteed for ninety days, and it is only proper for you to present some evidence of the date of purchase in case of tube failure during this period.

Before commencing to replace tubes in the receiver, turn them upside down and observe that some provision was made in their manufacture to insure that they will fit in their sockets in the correct position only. Among different tubes, there are various means of accomplishing this. Some tubes have their prongs unevenly spaced, some have two prongs larger than the other prongs. The most popular method during the past several years has been to provide in the very center of the tube base, a separate guide post, it might be called, on one side of which there is a ridge, the ridge in turn fitting into a slot in the hole in the center of the socket. Miniature tubes give the appearance of having one pin missing.

Figure 27 pictures the most commonly used arrangements for this purpose. As you prepare to replace a tube, look at the socket and at the tube base, and turn the tube around in your hand to the approximate position, so that you will not be attempting to force the tube into the socket in the wrong position. You will always be able to tell by examination, the correct position a tube should take in its socket, no matter which of the several methods were used in manufacture. NEVER FORCE A TUBE DOWN IN ITS SOCKET UNLESS YOU ARE ABSOLUTELY CERTAIN THAT IT IS POSITIONED CORRECTLY. If the tube appears to fit too tightly, or not go down easily, look at it again as a check, and make sure it is turned to the correct position. If you cannot see well into the set to look at the socket because of insufficient light, use a flashlight. If the view of any of the sockets is obstructed by other parts, and you do not wish to take the chassis out of the cabinet, the following procedure should help get the tube properly oriented. By feel, place the tube lightly on the socket and slowly turn it around and around, while pressing down. You may need to turn it around completely several times, but sooner or later, you should be able to feel the tube slip naturally and easily into place. Then you can press it down more firmly so that it seats well down into the socket. Avoid forcing a tube with more than a moderate pressure; when in doubt, repeat the process just described for finding the proper seating position.

In the matter of placing miniature tubes in their sockets, their base prongs or pins are quite small and fragile. Being easily bent, they require special care. If there is difficulty in getting one to fit into its socket, turn it upside down and look at the pins to see if they are all quite straight and parallel with each other. Try to look down directly at the socket while you hold the tube quite close to the socket, to see if the pins match up properly with the socket holes. If there is a bent pin, you can, with care, bend it back to the correct straight condition.

If there were any wire connections to the tops of any tubes, be sure to replace them correctly.

If the antenna was disconnected, be careful to reconnect it properly also.

Of prime importance is the idea of never overlooking small details, especially when re-

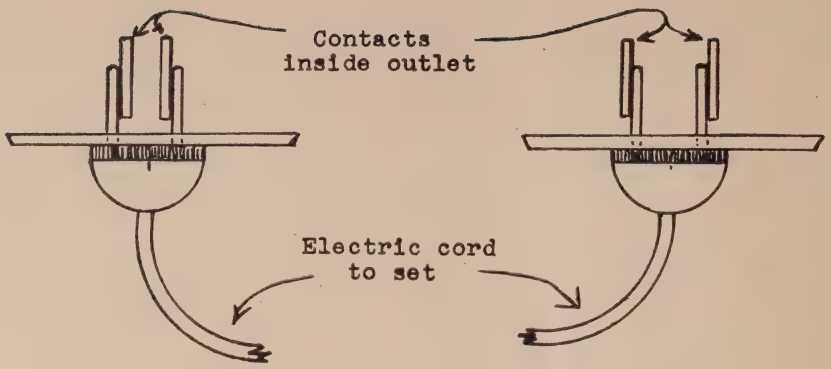


Figure 28.

assembling a set. Check and recheck your work, saying over to yourself, "Have I replaced every item correctly?"

If you replaced any burned-out tubes, the chances are good that the radio should now play when you have plugged it in and turned it on.

Caution: If you have replaced a burned-out tube having in its identifying number the letter W, X, Y or Z, and the tubes now light up, but there is still no sound in the speaker, do not leave the set turned on long, since you may have a shorted filter condenser. This refers to such tubes as 35W4 and 35Z5-GT.

6. If no burned-out tubes were discovered or or if they still do not light when the plug is in and the set turned on, you should give further attention to the electric plug and receptacle. Figure 28 shows how plugs make contact on the inside surfaces of the prongs in some receptacles, and on the outside surfaces of the plug prongs in other outlets. Observation of these two conditions will show how it is possible for a plug to make poor contact, or in some cases no contact at all, if the prongs on the plug become bent in the wrong direction, either through long use, or perhaps by being accidentally stepped on.

If you have made certain the receptacle is supplying current by trying a lamp in it, and have tested the tubes, but still the radio is inoperative, that is, the tubes are still not lighting at all, try squeezing the prongs together slightly as in figure 29 (a). Replace the plug in the outlet and turn the set on; if this avails naught, pull the plug out and try bending the prongs apart a little as in figure 29 (b). If neither attempt is successful, bend the plug prongs back as near to their original shape as possible. This is probably the normal, straight position illustrated in figure 28. This trick of bending plug prongs is a common one in dealing with appliances of all kinds, toasters, etc. You may have used it before, but if not, it is often useful in getting a loosely fitting plug to work properly.

7. Pull out the plug and turn it up, prongs facing you, if the set still doesn't seem to be getting current. If it is of the older style, having the wires fastened under screw heads, try tightening the screws with a screw driver. Examine to see that neither of the wires has slipped out from under the screw head. Also ascertain if a wire could be broken as it makes sharp bends coming into the plug or wrapping around the prongs. If a wire is broken, you will wish to cut the cord in two, about an inch back from the plug and reconnect it. This extra inch allows for eliminating the section of the cord which may be weakened from much bending in use.

Important: If, during normal operation, the electric cord on your radio has always been rather warm to the touch, you must not cut it for any reason. It has a resistor built into it, and the entire length must be kept intact to make the set operate properly. Fortunately, there are very few still in use; they have not been used in receiver manufacture for many years. More modern tube design has made them unnecessary.

The following suggestions should enable anyone to reconnect the type of plug which uses screws to make contact between the plug prongs and the wire coming from the set.

A. Cut the wire in two, about an inch back from the plug. If you have no wire cutters, use a knife which you are not trying to keep extra sharp.

B. Unscrew the screws which hold the wire ends in place. Unscrew them several turns, and pull out the old wire ends.

C. With a reasonably sharp knife blade, skin about one half inch of the insulation from the ends of the two wires. You will need to exercise care not to cut into the wire as you do this. Hold the knife blade somewhat at an angle as if you were sharpening a pencil, and cut slowly, stopping just before the blade edge reaches the wire. Turn the wire slightly in your fingers and do this same thing again in a new place. Continue in this

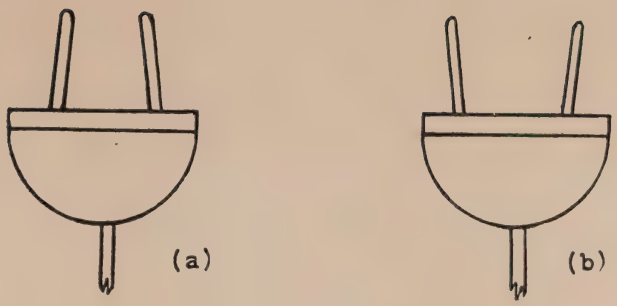


Figure 29.

same manner, moving around the circumference of the wire until you have cut through the insulation, but not clear into the wire itself, completely around the wire. Now, clamping this loosened piece of insulation between the back of the knife blade and your thumb, pull the piece of insulation off. If it doesn't come off easily, try cutting again, just a shade deeper. Do this same thing on both of the two wires in the cord.

D. Scrape the wire with the back of the blade, or with a dull blade, until it is bright and clean.

E. The wire is almost certainly stranded, and the loose ends must be kept tightly together to keep loose ends from shorting against the other wire, or against the opposite terminal screw. Take the ends of one of the wires between the thumb and forefinger and twist the strands tightly together, similar to a dandy of the Gay Nineties, twisting the loose ends of his mustache.

F. Now push the two wire ends up through the plug, but instead of wrapping the wires directly around the screws, loop each wire end around the prong and then under the screw head. Examine other plugs on lamps and appliances to see how they are fixed. Caution: Always wrap a wire to the right around a screw, since if it is wrapped to the left it will tend to slip out from under the screw head when the screw is tightened.

G. Tighten the screws down securely, taking care that the wire does not slip out from under the screw heads. If the wire does slip out, loosen the screw, twist the wire ends again, the same as before, and rewrap around the prong and screw.

8. If the plug is one of the newer kinds of soft rubber or plastic with no bare wires or screws exposed, there is a possibility of a wire being broken or loose inside the plug and your not being able to detect it. If you have progressed this far and have not yet met with success, it is worth a try at putting on a new plug.

There are several kinds of plugs on sale at dime stores and hardware stores, some of which require no tools and no wire skinning. They are exceedingly simple to install and come with complete directions. If you are installing a new plug, you might do well to purchase one of this kind. However, if you can only find the old style using screws, the foregoing instructions should be of help.

(2) LOUD, BELL-LIKE TONE (Microphonic Tube)

If, either occasionally or consistently, you hear a rather loud, clear tone, like the sustained ring of a bell—not the clang of the stroke of a bell, but the clear ringing tone which remains afterward—you probably have in your set what is called a microphonic tube. This noise is not a whistle, and not a hum, but is constant in pitch, and usually begins softly and builds up to a loudness sufficient to drown out all program material. It may start when the table or floor is jarred, and sometimes you may be able to stop it temporarily by tapping the radio cabinet; also you may start it the same way. In particularly severe cases, it may commence virtually of its own accord, and be almost continuous.

Turn the set around and remove the back cover if the set has one. If you have a small table model, see Chapter IV, Section (1). Now, with the set turned on and the volume turned up fairly high, using the rubber-eraser end of a lead pencil as a sort of hammer, gently tap on first one tube, then another. You should have no difficulty in determining which tube is the guilty one. In very bad cases, thumping other tubes than the correct one, or even tapping the set itself may cause the tone to begin, so to be certain, keep tapping different tubes, ever so lightly, until the most sensitive one is located, and this will be the bad one.

When you have found the microphonic tube, buy a new one of the same number and your difficulty should be cured.

This particular trouble is not as common in A.C.-D.C. radios as it is in some of the larger models. It is fairly common in portable sets, and has at times been very prevalent in certain television sets. In some television sets you will not be able to reach the tubes while the set is in operation due to the safety interlock on the back

cover, but some TV models have the interlock so arranged that the set can be operated with the back off. On these, the tubes which are under the shield cage could not possibly cause this microphonic noise anyway, so, if you can, make the same test described above, for TV sets as well as radio receivers.

In either TV or radio sets, do not overlook tubes which are covered by individual shield cans, as one of them might be the guilty one. Sometimes these shield cans come off with a straight upward pull, while others must be first pushed down slightly, while turning slightly to the left, then lifted off.

Some television sets have a few tubes which can be reached through a small opening in the bottom of the cabinet. A particularly bad actor in this matter of microphonics was the 6J6 tube in a large number of sets put out especially in the early part of 1949, and which was available in just this manner. If you are looking for possible tube trouble, inspect your set to see if any tubes are in this location.

(3) SCRATCHY NOISE WHEN MOVING THE DIAL

A troublesome situation sometimes develops in radio sets which you can easily correct for yourself. When you tune from one station to another, if you hear a scratching, grating noise as you turn the dial, your tuning condenser shaft is probably dirty. Do not confuse this condition with a noisy volume control. The trouble we are here discussing occurs only when turning the tuning dial or, if it is prevalent almost continually, it can be greatly increased by turning the tuning dial.

Before beginning the work of curing this difficulty, secure a bottle of carbon tetrachloride at any drug store. If this exact product is not available, get a cleaning fluid which uses carbon tetrachloride as a base. Also get a medicine dropper.

A. For safety reasons, remove the plug from the electric outlet.

B. Remove the knobs from the front of the set. First, look around the full circumference of the knobs to see if they are held on by set screws; if so, you will need to loosen them with a small screw driver, obtainable for ten or fifteen cents at the dime or hardware store. Do not take the screws clear out; just loosen them a turn or two. Knobs on most of the fairly modern sets, however, come off when you grasp them firmly and pull straight forward. They sometimes fit rather tightly, and you may need to grip two opposite sides with the thumb and forefinger of one hand, and then reach over with the other hand and place the other forefinger and thumb also on the knob. This will give you a firm grip on four sides of the knob. You may need another person to hold the set down, if it is a small cabinet model.

C. Remove any screws or bolts which come up through the bottom of the cabinet into the chassis to hold the chassis in place. On some table models, there are two or four screws just at the rear of the chassis, one or two being at each end, which when removed, allow the chassis to pull out to the rear like a drawer.

D. Some sets have the speaker mounted on the chassis, so that it comes right along when pulling the chassis out of the cabinet. In other receivers, the speaker is mounted separately on the cabinet, in which cases you will need to use care not to break the wires running from speaker to chassis. Many sets have these wires terminated on a removable plug. However, if the wires are permanently connected to both speaker and chassis, you will need to be very careful not to pull the chassis far enough apart from the speaker as to stretch the wires, or else take the speaker out of the cabinet also. The latter is preferable from the standpoint of ease in working on the chassis when you once get it out. Generally the wires between the two items are long enough to allow some leeway of movement in working; just keep in mind the danger of wire breakage, guard against it, and you'll not go wrong. In many older models, there are other parts, such as switches, which were mounted on the cabinet with wires running from that position to the chassis; in these cases, the same suggestions apply as were made in discussing the wires to the loudspeaker. In general, make a habit, as you pull a chassis from a cabinet, to look for any wires at all which might connect to a part mounted directly on the cabinet.

E. Some table models have a handle on the top which has end posts protruding down into the inside of the cabinet. Often space inside these cabinets is at so much of a premium that the chassis will not pull out without this handle being lifted up. Otherwise, some part such as the dial or speaker may catch on one or both ends of the handle. Notice this possibility and, if necessary, prop the handle in its extreme upward position by jamming a folded newspaper or block under the handle.

F. After removing the chassis from the cabinet, turn it so you are facing the front. Place the knob on the shaft with which you would be tuning the set from station to station.

G. Turn the tuning knob back and forth while observing what action is taking place. You will see the rotor or moving plates of the variable condenser meshing into and out of the stationary plates. At the two ends of the variable condenser and also at one or more points along the shaft, you should be able to locate some kind of friction contact points between the rotating shaft and the frame of the condenser. These points of contact probably have collected moisture, grease and dust, thus causing poor contact and consequently causing noise when turning the tuning control. Figure 30 pictures a two-section condenser and indicates these points of contact. Some condensers have as many as four sections.

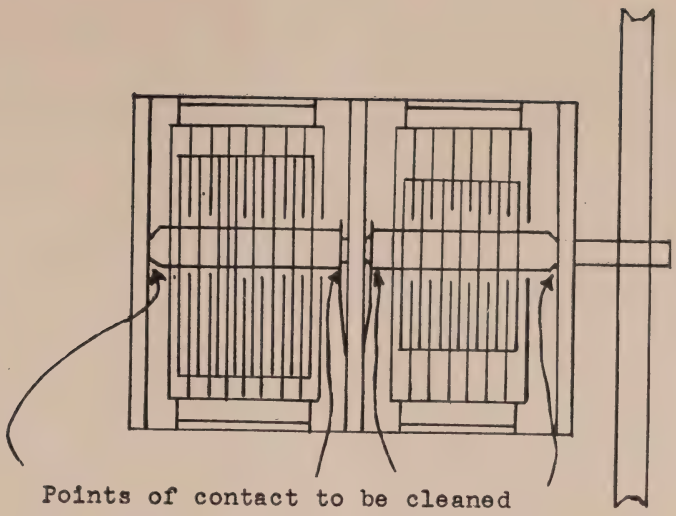


Figure 30.

H. Fill the medicine dropper about half full of carbon tetrachloride. Now let the carbon tet' (as it is popularly abbreviated) drip rather generously down over the points of contact indicated in figure 30, while at the same time moving the tuning dial back and forth fairly briskly through its entire range, so the cleaning action will affect the condenser shaft clear around. Repeat the action several times. Carbon tet' evaporates quickly and is harmless on wires and radio parts, so do not worry if some drips down. Also carbon tet' is used in fire extinguishers, so is certainly not the least dangerous as far as fire hazard is concerned. However, avoid breathing directly, strong vapor from carbon tet'.

I. While the set is out of the cabinet, if you have a vacuum cleaner with a blower attachment, point the blower into the condenser and all over the set to blow out dust thoroughly. This is an operation performed as routine by all good servicemen.

J. Using a flashlight, if necessary, look carefully straight down into the tuning condenser to see if there is any evidence of one or more rotating plates having become bent and is/are rubbing on one or more stationary plates. Fortunately, this happens very seldom, but when it does, it causes much noise when turning the tuning dial, and usually blanks out the program entirely. If you do discover a case of this kind, use a knife blade or thin screw driver blade to very slightly bend the offending plate away from the one against which it is rubbing. Use extreme care not to bend it too far and cause it to rub on the plate on the other side.

Push all the tubes down firmly in their sockets, and see that wire connections to the tops of tubes, if any, are securely in place.

Before returning the chassis into the cabinet, if it is convenient to do so, it is well to try the set so you will know whether or not the cleaning operation has been successful. If there still is noise when you turn the dial, you can repeat the cleaning operation once or twice more. In those extra stubborn cases, if there is space to do so, it sometimes helps to use an old tooth brush on the friction points of contact you are cleaning. There is not always space in which to do this, but if there is, it is worth a try. See that you do not leave any broken bristles in the contact points to cause future trouble.

Return the chassis to the cabinet, remembering carefully to return all wires, the speaker connections if they were removed, and anything else which was disturbed, to their original condition. If the set does not work when first turned on, make sure the plug is in the outlet, and go back over all the things done in removing and replacing the chassis, and ten to one you'll locate some detail which you overlooked in replacing the chassis into the cabinet.

(4) PROGRAM DISTORTED OR MUSHY

Have you ever seen a photograph taken with the camera slightly out of focus? Did everything seem blurred, as though the subject just couldn't seem to come through sharp and clear as you wished it to? When a radio program sounds like this looks,—blurred, not clear and sharp—commonly it would be described as mushy; technically the term is distorted. It is a reasonably common

complaint, especially in small A.C.-D.C. receivers, and very often is due solely to a defective tube. If, when the set is first turned on, the symptom is either not present at all, or at any rate is not severe, but increases as the set is left turned on, and gets worse and worse as the set gets warmer and warmer, such is even more of an indication that the trouble is a faulty tube.

If your receiver is in this condition, look for one of the following tubes, if you have an A.C.-D.C. set:

25L6 35L6 50L6

If you find one of these three, have it tested with special emphasis being placed on testing for gas. Better yet, and far more conclusive, buy a new tube like the one in your set and install it in place of the old one. Even if it does not entirely cure the trouble, your money is not wasted; keep both tubes, the extra one for a spare; since these tubes are some of the worst offenders in the way of complete failures, it probably is only a matter of time until you would need one anyway. However, if installing the new tube stops the mushy or distorted condition, throw the old one away.

If in doubt how to reach and remove tubes, also how to look for any special one, see Chapter IV, Section (1).

In other than A.C.-D.C. sets, tubes which can cause this difficulty include:

6F6 6L6 6V6

No set is apt to have more than one different kind of these three tubes, but one set may have two 6F6's, two 6L6's, or two 6V6's.

In sets other than A.C.-D.C. models, in looking for this particular trouble, it would be a good idea to have all tubes tested, stating to the person doing the testing, the fact that you are looking for a possible gassy tube. Some cheaper tube testers cannot test tubes for gas, but most better testers do have a provision for this test.

(5) LOW VOLUME OR NO PROGRAM AT ALL IN OLDER SETS

In late years we have become accustomed to the modern day receivers being so very sensitive that they require little or no antenna for satisfactory operation. Many, of course, have built-in antennae. The author has been called in several instances, however, to see about sets of more or less ancient vintage, and at least one set not so ancient, none of which had anything more seriously wrong with it than the lack of an adequate antenna. The owners had fallen into the habit of thinking in terms of all sets being alike in their demand for an antenna, and since the newer sets require little or none, the assumption led to unsatisfactory performance of the older set.

Whenever you are not satisfied with the strength or loudness of program reception, check the antenna requirements of your set. Look at the rear of the set for a binding post labeled A, Antenna, or perhaps simply Ant. Some sets do not have these binding posts, but have a loose wire coming out of the set, to be connected directly to the antenna, and a wire to be connected to the ground. Ground, if a binding post, will be labeled Ground, Gnd. or G. The ground connection is usually not important for good volume, but the antenna is, in these older models of receivers. When there are two wires coming out of the rear of the set to be connected to the antenna and ground, the antenna wire is always of a lighter color than the ground wire. Black is very commonly used for the ground wire, but just remember that if there are two wires, the darker color goes to the ground.

If you desire, the ground wire or terminal may be connected to a radiator, or preferably a cold water pipe, but NEVER, NEVER to a pipe carrying cooking or illuminating GAS.

The wire or terminal binding post for antenna connection should be connected to a wire about 50′ to 100′ long, the longer wire being desirable if you live more than 25 or so miles from the stations to which you listen. In the order of preference, this wire may be disposed of as follows:

1. Hung in mid-air, on insulators; (if to a tree, a strong screen door spring, or two springs tied side by side, it should be between the antenna and the tree to take care of wind sway).
2. Hanging loosely out of a window; wire for this should be insulated throughout its length, but a bare wire will work if it does not touch any metallic objects.
3. Tacked down around the baseboard inside the room. Wire used in this manner should be insulated throughout its length.
4. As a last resort, if you live fairly close to stations, you might get by with loosely bunching or coiling the wire on the floor behind the receiver.

(6) LOCATING DEAD TUBES IN NON-A.C.-D.C. RECEIVERS

It is sometimes possible for a tube to be burned out and the set continue to function in some manner or other. One example of this is when a set has two output tubes in what is called push-pull. One of these tubes can be burned out and the other continue to carry the load sufficiently to keep program coming out of the speaker, though slightly reduced in volume, and usually somewhat mushy or distorted. If you notice this symptom, leave the set turned on for a length of time sufficient for all tubes to become thoroughly warm, five minutes or more, at least. Now, feel all tubes with your fingers. If one is burned out, it will be almost cold. It may be slightly warm from absorbing heat from nearby tubes, but there is not likely to be any doubt in your mind as to which tube is completely dead. You cannot rely on visual inspection, since so many tubes are coated inside with a very dark coating, making the glass virtually opaque. In the

case of glass tubes, visual inspection may augment the feeling test, but with metal tubes one can tell absolutely nothing by looking at them.

Sometimes there will be conditions other than the one suggested here, which you may feel could be due to a dead tube. A completely inoperative set (remember we are discussing non-A.C.-D.C. sets), easily can be due to a burned-out tube, and still all the other tubes be lighted and warm quite normally. In a sense, this is the primary difference between A.C.-D.C. receivers and the conventional variety—one dead tube in an A.C.-D.C. set will render all tubes useless until the bad one is replaced with a new tube, while in the conventional receivers, only the burned out tube will be dark and cold.

There are cases other than those involving the output tubes discussed in a previous paragraph, where the program will manage to feed through, though weakly. So anytime you feel there is a possibility of a tube being burned out, remember that in a non-A.C.-D.C. receiver, a burned-out tube often can be located by feeling all tubes, since only the defective one will be dark and cold.

(7) IF TUNING KNOB DOES NOT PROPERLY TURN DIAL

Often a radio set gets to the point where turning the knob has an aggravatingly slight effect on the tuning dial. This, of course, is caused by a slipping dial cord. The dial cord is a sort of belt arrangement wrapped around the tuning knob shaft (usually about one and one-half turns), and in turn around a large drum mounted on the tuning condenser shaft. This is done to provide several turns of the knob for one rotation of the tuning dial.

Such trouble can be remedied in most instances in one of two ways. If your tuning dial appears affected in this manner, remove the chassis from the cabinet in accordance with suggestions in Section (3), this chapter. In figure 30 can be seen the drum on the shaft of the tuning condenser around which the dial cord is wrapped. If, when the set is out of the cabinet, you will observe from the front, you will see that the ends of the dial cord come through holes in the outside of the drum and are anchored to small hooks, usually by means of one or two small springs. The springs, if used, are supposed to keep the dial cord tight and eliminate this slippage. However, over a period of time, the dial cord stretches and the tension is no longer sufficient.

Whether or not the springs are used, if you have fairly nimble fingers, you can generally tighten up the cord by retying a knot over the hook to which it is anchored, and drawing the cord a little tighter as you do so.

If the ends of the cord are too short for this and you wish to attempt installing a new cord, use a good grade fish line, preferably rubbed with a little resin. Examine carefully the old cord as to how it enters and leaves the drum, which way the cord runs as it comes out of the holes, how many times it is wrapped around the tuning knob shaft, etc. If desired, draw a sketch of the arrangement before removing the old cord. Then, put on the new cord exactly as the old one was.

If the cord is not too loose, but simply appears dry, get a small piece of resin. Resin should be obtainable in some dime, hardware or music stores. While turning the tuning knob rub the resin on all sides of as much of the cord as you can reach.

Either the resin or tightening treatment, depending upon the extent of the difficulty, should correct the trouble.

The above description assumes a radio with the drum arrangement as described. However, in the cases of a more complicated dial mechanism, though they are greatly in the minority, the same ideas apply. An examination will show you that no matter how many pulleys and brackets the cord goes around in its journey to move a pointer on the dial, it eventually makes one or two revolutions around the tuning knob shaft. It is here that the slipping almost always occurs. If it appears impossible to tighten the cord in any way, rub it with resin as described above, though there is almost invariably some means for cord tightening.

CHAPTER V

HOW TELEVISION PICTURES ARE PRODUCED IN YOUR TV SET

The explanation of what happens inside a television set in order for a picture to appear on the screen probably will be more interesting to the reader, also easier to understand, if the action inside the picture tube itself is examined first. As a matter of fact, in almost every home TV receiving set, the screen on which the picture appears is actually the large, flat, glass end of the picture tube. The picture tube is installed in the cabinet in such a manner that this flat surface or face is seen directly by the viewer. These sets are quite appropriately called direct view sets. The very few exceptions to this arrangement are projection sets. Since larger and larger picture tubes have been developed and their price brought down to reasonable levels, there is little need for projection model sets in a home, because the only reason for projection models is to provide larger pictures; and this was done by the expensive method of providing a system of lenses and reflectors. Inasmuch as there is almost no chance that your set is a projection model, this explanation will assume the existence of only the direct view model.

(1) THE SHAPE OF THE PICTURE TUBE

In its physical shape, the picture tube somewhat resembles a common funnel. The large end of the picture tube, instead of being open as on the funnel, is covered with a thick, flat piece of glass which is the picture screen. The small neck of a picture tube is straight, where a funnel is usually tapered toward the small end. At the extreme small end of the picture tube is the base to which connections are made down into the set proper, by means of several wires more or less bunched together in the form of a cable. Comparative sketches of a common funnel and a picture tube appear in figure 31, (a) and (b) respectively.

The large, screen end of the picture tube is made of very thick glass to withstand the great air pressure on its large area. The reason for this is that picture tubes as well as other television and radio tubes and electric light bulbs, for that matter, are evacuated to a high degree of vacuum. If a picture tube breaks, an implosion results, and the danger from flying glass is as bad or worse than if it were an explosion caused by internal pressure. This situation makes it necessary that

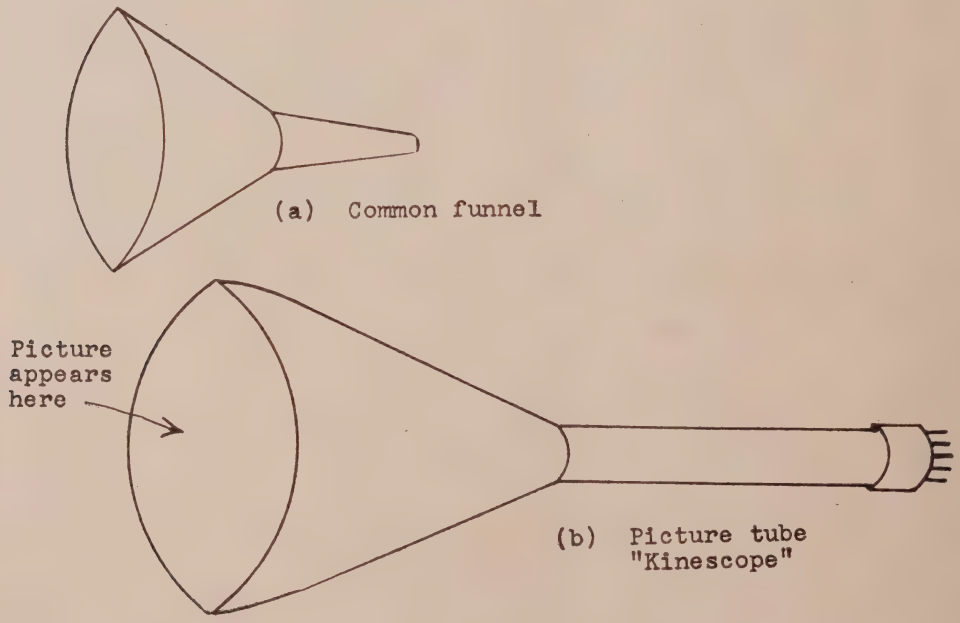


Figure 31.

certain precautions be taken in the handling of picture tubes. Although no instructions in this book suggest the removal or handling of the picture tube, in the interest of completeness these precautions are here stated. Wear heavy gloves and goggles, the latter preferably of an unbreakable variety. Religiously avoid scratching the glass of the picture tube, especially the screen end, as this may cause a crack and finally result in breakage. NEVER pick up or handle a picture tube by the small neck; ALWAYS use both hands and hold it by the large, heavy end. If necessary to set it aside for any reason, spread a clean cloth on a smooth solid surface of a bench or table, and set the tube on the large flat end, with the small neck sticking straight up in the air. If you wish to clean the screen end of the tube, clean it just as you would a highly prized mirror to avoid any chance of scratching it.

Recent manufacturing advancements have allowed production of picture tubes with a rectangular screen end, rather than the conventional round type, but they are not yet in very wide use. The new shape is desirable, in that the same size picture can be had in smaller cabinet space. The picture as transmitted from the station is rectangular, exactly 4″ wide for each 3″ high, or to put it another way, three-fourths as high as it is wide. One can see that putting this shape picture on a round screen results in at least some wasted screen space at the sides and top and bottom. No confusion should result in considering the round type, since the difference is purely in the physical shape of the screen end of the tube.

(2) THE PICTURE SCREEN

The inside surface of the screen end of the tube (the large flat area) is thinly coated with a material which glows for an instant when struck by a fast-moving electron. It isn't necessary to know what electrons are in order to gain somewhat of an understanding of the action inside the picture tube. Just keep in mind that the coating on the inside surface of the picture tube screen glows when it is bombarded by fast-moving electrons, and that the faster the electrons are moving, the brighter the screen glows, that is, of course, up to certain limits.

(3) THE ELECTRON GUN

Inside the small neck of the picture tube, pointed toward the screen end, is a unique little piece of apparatus called an electron gun. When the set is in operation, this little gun is actually shooting out a tiny stream of electrons directed toward the screen end of the tube.

The position of the electron gun inside the tube is permanently fixed, pointed toward the center of the tube screen. If no other part of the set were operating except the electron gun you would see in the center of the screen, a tiny bright spot, somewhere near the size of a pin head. If this condition was allowed to continue for very long, a spot would be permanently burned on the screen. Fortunately, TV sets are so designed that it is virtually impossible for the electron gun to operate without other sections of the set also being in operation, thus making it extremely unlikely that a spot would ever be burned on the tube's screen during normal home use. The idea is mentioned only to help make clearer the action of the electron gun, and to emphasize the statement that the electrons are directed toward the exact center of the screen as they leave the gun. The electron gun might be compared to a machine gun, continuously firing a stream of bullets, except that the number of electrons being put out by the electron gun each second of time would far exceed the number of bullets ejected from the machine gun in one second. The position of the electron gun in a picture tube is shown in the outline diagram, figure 32.

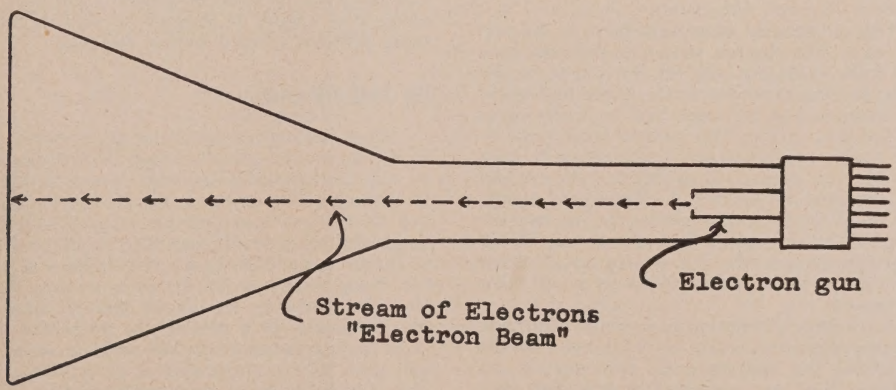


Figure 32.

(4) DEFLECTION

Do not let the word deflection frighten you; it is not a technical term in the strictest sense, but simply means, bending something from its normal path of travel. In this case, we are referring to bending or deflecting the stream of electrons which leave the electron gun originally aimed in a straight path directly toward the center of the tube screen. The need for doing this is quite obvious; one can readily see that a bright spot in the middle of the screen is of no value in itself; to produce a picture on the screen, the whole screen area must be brightened. If this is to be accomplished by the tiny stream of electrons, it is plain that something additional must be brought in.

Remembering that it is desired to spray or sweep, as it is more correctly stated, the entire screen area with the electron beam (stream of electrons), the method of doing so will be more easily understood by making a comparison with a familiar situation.

If you had a garden hose nozzle in your hand, adjusted for a strong, straight stream, and wished to cover a comparatively large area of a wall with water, how would you proceed? It is likely that you would begin at the top of the wall, and move the water stream back and forth from side to side, while at the same time gradually working down toward the bottom of the wall. Suppose also, that the nozzle were fixed in a secure position so that it could not be moved back and forth, since that is the situation in the case of the electron gun. You could still cover the wall, by simply placing the flat palm of your hand against the stream of water and so deflect the stream to one side or the other. By varying the position of the hand, the stream can be deflected in any desired direction,—down, up or to either side. It is easy to see how one could deflect the stream of water first to one side, then to the other, beginning at the top of the wall and slowly working down toward the bottom until the complete wall has been drenched with water.

This is precisely what takes place in the picture tube. The electron stream is deflected back and forth from one side of the screen to the other, starting at the top of the screen and working downward at the same time to finally cover the complete screen. The process takes place so very quickly that your eyes cannot begin to keep up with it; it happens so swiftly that the eye and brain imagine the screen to be illuminated equally well on all parts at any given time. In fact the beam of electrons moves from side to side 15,750 times each second. Also it is moving up and down from the top to the bottom of the screen 30 times per second.

A complete description of how this deflection is managed becomes rather involved, but it should be pointed out that there are two ways it can be done. Both are employed in television sets. One way is to place a small metal plate on each side, and above and below the normal path followed by the electrons as they leave the electron gun. This makes four plates in all—one above, one below, and one at each side. By applying what is known as an alternating current to these plates in the proper manner, the beam of electrons can be bent or deflected both side to side and up and down at any desired speed, depending upon the exact nature of the alternating current. (To be technically correct, to the letter, it should be stated that an alternating voltage is applied to the plates, but the term alternating current is more common in usage and is not too far wrong to use for explanation purposes). This type of deflection is used primarily in picture tubes smaller than the 10″ size.

The other method, and the one employed almost exclusively in larger tubes, is that of subjecting the electron stream to a strong magnetic field. This simply means passing the stream of electrons between the poles of a strong magnet. You may or may not be aware that one type of magnet is made by simply passing a current of electricity through a coil of wire. If there are a large number of turns in the coil and a rather high value of current is sent through it, a very strong magnetic field can be produced. To be able to deflect or bend the electron stream both horizontally (from side to side) and vertically (up and down), four coils are used, just as four metal plates are used for the other method. In this case, an alternating current is passed through the coils so the magnetic poles will be constantly changing their direction (from North Pole to South Pole) and so cause the beam to move first one way and then the other. You see, a magnet of any kind is like a common compass; it has a north and a south pole. If this explanation seems a little steep, just bear in mind that the principle thing to remember is that the electron stream as it is directed onto the tube screen is moving back and forth from side to side and up and down at the same time, so as to give the eye the impression that the screen is glowing equally bright over its whole area. Figure 33 suggests an electron beam being deflected upward leaving the gun.

(5) THE FRAME

When the electron beam has begun at the top of the screen and gone back and forth from side to side and gradually worked its way down to the bottom of the screen, to exactly cover it once, one thirtieth of a second has elapsed, and one single still picture could have been produced. This is exactly comparable to one single frame of picture being thrown on the screen in a movie theater. You probably are aware that to show a moving picture in a theater, the projection machine merely projects onto the screen a series of still shots with a slight amount of action occurring between each two consecutive pictures. The eye, due to what is termed persistence of vision,

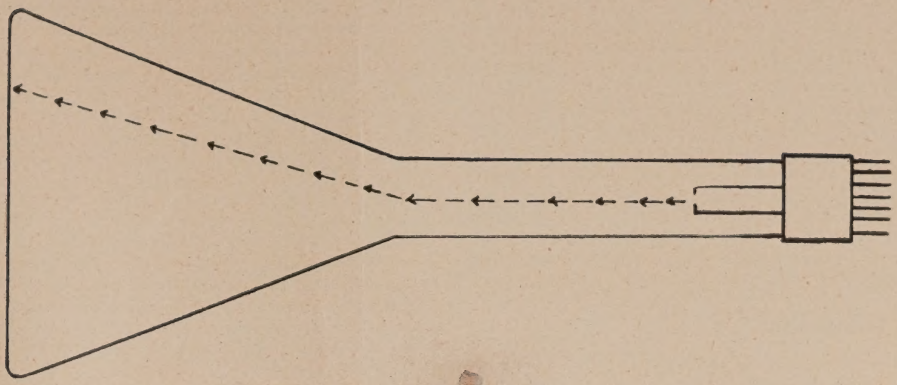


Figure 33.

imagines the movements to be smooth and continuous.

The same thing is done in television. After the electron stream has covered the screen one time, thus producing one complete picture (which has occurred so quickly, that little or no action has taken place), the electron beam is returned to the top of the screen to begin over again; this time, as it proceeds across and down on the screen for the next single picture, some movement or action may have taken place. It will, however, be slight, and the process is repeated so fast that the eye, as previously stated, due to persistence of vision, presumes the movements to be smooth and continuous.

(6) THE PICTURE ITSELF

Up to this time, the electron beam or stream has been described as though it were of the same strength at all times, making the screen bright to the same degree all over. This, of course, is not quite true when an actual picture is being viewed, since one part of the screen may be almost black at the same time another portion is quite bright, almost white. Such would be the case if a man were shown in a black suit standing on a well-lighted stage, or perhaps in the sun outdoors.

With a little thought, you probably could figure out how that is done. Coming back to the comparison with the hose and the stream of water playing on the wall. If you wished one part of the wall more thoroughly soaked than another part, wouldn't you partially shut off the stream as you passed over the part which it was desired to leave the dryest? Since we have seen that electrons striking the screen make it glow, it follows that if fewer electrons strike a certain part of the screen, that portion of the screen will be darker than an area which is more heavily bombarded with electrons. Conversely, when the electron stream is heaviest, the part of the screen which is being bombarded at that instant will be brighter. Thus as the electron stream moves over the screen, variations in the number of electrons allowed to actually reach the screen can create shaded and even totally dark (black) areas. Thus a picture can be reproduced. The electron stream is (by means of certain apparatus in the set) choked down, or clear off during the time it is covering that part of the screen which is supposed to be dark gray or black. When a certain area of the screen needs to be white, the electron stream is allowed to flow unmolested during the instant it is spraying that part of the screen.

(7) ORIGIN OF THE PICTURE

The question naturally arising in one's mind at this point is, what causes the electron stream to be stronger or weaker at the correct times in order to produce a picture.

For the answer to this question, we should proceed all the way back to the camera in the television broadcasting station.

You probably know that in taking pictures with an ordinary camera, the scene which is to be photographed is focused onto a light-sensitive film at the back of the camera by means of the lens on the front of the camera. Somewhat the same thing takes place in a television camera. By means of lenses, the desired scene is focused onto a light-sensitive plate inside the TV camera. This light-sensitive plate, in a sense, corresponds to the screen coating in the picture tube in your receiver. It is, in fact, located inside a tube which we shall call the camera tube. Various proper names for it are iconoscope,, abbreviated "Ike," orthicon, and image dissector. We will simply refer to it here as the camera tube. Like the picture tube in a home TV set, the camera tube has a stream of electrons moving back and forth across the light-sensitive plate, and at the same time moving down toward the bottom. Indeed, it

must be doing so in precise accordance with the electron stream in your picture tube, or you'll never get a picture! Now remembering that a scene is focused onto this plate, it is clear that some parts will be darker gray, black, or white depending on the scene which is being televised. The camera tube is so made that it literally generates tiny amounts of electrical energy as the electron stream moves over the lighter or darker (as the case may be) portions of the scene. This electrical energy, feeble though it be at that point, is the television picture signal which is to be sent out by air and received by your antenna and passed on to your set.

(8) SUMMARY

Summarizing the action from the television camera to the picture tube in your TV set may make the process clearer in your mind:

By means of lenses, a scene is focused onto a light-sensitive plate inside the camera tube. The camera tube, of course, is located in the TV camera.

The camera tube, like the picture tube in your set, has an electron gun which is shooting a stream of electrons toward the light-sensitive plate, on which the scene is focused.

The electron beam in the camera tube is being swept back and forth across this scene, and at the same time swept up and down, so that it completely covers the scene in exactly one thirtieth of a second. In other words, the scene will be "swept over" or "scanned," as it is often called, precisely thirty times per second. You remember that is the number of times that the electron stream in the picture tube in your set covers the screen—thirty complete times a second.

By means of special equipment in the transmitter at the TV broadcasting station, electrical energy in the form of pulses is generated and mixed into the wave or signal which is to be sent out on their antenna along with the sound and picture waves. These pulses are used in your receiver to keep the electron beam in your picture tube in EXACT STEP with the electron beam in the camera tube, so when one is starting at the top of its screen and moving across, the other will also be beginning at the top and moving across. They will both reach the bottom, and be returned to the top at precisely the same instant!

With this movement coordinated perfectly, we can see that if we could just cause the electron stream in the picture tube to "pick up," or generate energy in amounts varying according to the shading in the scene it is passing over, energy could be used to put a picture on the screen of your set.

That is just what it does! The light-sensitive plate is made of such a material, that with a scene focused on it, when the electron stream strikes the brighter areas of the scene, more energy is generated by the camera tube than when it is striking a darker area. The camera tube then generates varying amounts of energy, depending upon the shading of the scene on the light-sensitive plate at the time.

These energy variations are amplified many, many times, and are broadcast by the TV transmitting station. When they arrive in your TV set, they are again feeble, due to their long journey through the air, so they are again amplified in your set and are finally impressed on a certain element in your picture tube. There it has the ability to "choke off" or weaken the electron stream as it is passing over a portion of the screen which is supposed to be dark in order to reproduce the picture on the camera tube at that instant. It also allows the electron stream to flow freely for the parts of the screen that are meant to be white, and at varying strengths for shades of gray in between.

The sound portion of the TV program, picked up by regular microphone, is handled as a separate item, and is "mixed" with the "picture signal" just before they enter the station's television broadcasting antenna.

The signal or wave, whichever you choose to call it, that is being sent out into the air by a TV broadcasting station contains three separate parts:

1. Energy variations which carry the picture.
2. Energy variations which carry the sound.
3. Energy variations which keep the electron beam in your picture tube in EXACT STEP (synchronism) with the electron beam in the TV station's camera tube.